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CONTENTS

PAGE

Medical Inventions and Discoveries 705
Knowledge and World Progress. By Prof. Allan Ferguson 707
Pliny Revived. By F. S. Marvin 708
Animal Collecting. By J. E. Hamilton 709
Gliding and Soaring Flight. By Prof. D. Brunt 712
Science, Logic and Philosophy. By Dr. Harold Jeffreys, F.R.S. 716
Cambridge Meeting of the British Association 719
News and Views 720
Letters to the Editor:
Recent Solar Eruptions, Auroras, and Magnetic Storms.—A. J. Higgs and R. G. Giovanelli . 746
Eddington's Fundamental Equation.—H. C. Corben 747
X-Ray Study of Thymonucleic Acid.—Dr. W. T. Astbury and Florence O. Bell . . 747
Structure of Metals.—R. A. Stephen 748
Biological Synthesis of Amino Acids from Atmospheric Nitrogen.—Prof. Artturi I. Virtanen and T. Laine 748
The Most Probable Place of Location of the Genes in the Chromonemata.—Prof. Dontcho Kostoff 749
Function of the 'Fossula spongiosa' or Spongy Furrow in Reduviidæ (Rhynchota).—N. C. E. Miller 749
Modern Studies of the Foraminifera.—Dr. W. A. Macfadyen 750
The Prague Sero Reactions for Cancer.—Frants Bergh, Dr. O. M. Henriques and J. Schousboe 751
Value of Young's Modulus for Nickel Wire as Influenced by the Diameter.—Dr. T. F. Wall 751
Reflecting Power of Ultra-pure Aluminium.—Dr. P. Jacquet and Dr. L. Capdecomme . 752
A Whale Story.—A. S. E. Ackermann 752
Albino Frogs.—W. A. Smallcombe 753
Research Items 754
Plant Protection in the Soviet Union. By R. C. Rainey 756
Noise and Housing 758
Association between Nematodes and Insects 758
Science News a Century Ago 759
Societies and Academies 760

SUPPLEMENT:
Social Relations of Science 723
Representative Opinions 725

Prof. F. C. Bartlett, F.R.S.
Prof. J. D. Bernal, F.R.S.
Prof. P. M. S. Blackett, F.R.S.
Prof. P. G. H. Boswell, O.B.E., F.R.S.
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Sir Henry Tizard, K.C.B., F.R.S.
H. G. Wells.

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Medical Inventions and Discoveries

THE report of the Medical Research Council for the year 1936–37 recently issued* refers to the present unsatisfactory position in Great Britain of the medical treatment known as chemotherapy, which consists in the administration of chemical compounds synthesized in the laboratory and found to have specific actions on the infective organisms causing particular diseases in man and animals. The discovery and production of chemical compounds of value in this way have, the report states, "depended almost entirely on German science and industry, and still so depend", although the subject has special significance for the British Empire with its immense responsibility in tropical countries. Malaria, for example, still holds the premier place as a cause of premature death and inefficiency in the Empire, and it is estimated that in India alone at least 100,000,000 persons suffer from the disease each year, with a direct financial loss variously estimated at from £23,000,000 to £50,000,000 per annum, the indirect losses being still greater. The report then continues as follows:

"Were the matter only one of prestige, the situation would be serious enough, but the financial aspect is also of much importance. Foreign firms have built up large organizations and have spent large sums of money to advance this aspect of therapeutics. They naturally, therefore, expect to derive substantial profit from any practical discoveries. Not only do they take out comprehensive patents to cover these chemical agents, but they do not as a rule grant licences for manufacture in this country; in case of war, therefore, the British Empire might be deprived of essential drugs, as in the case of salvarsan compounds in 1914."

The success of Germany in the field of research in chemotherapy has been dependent on a system in which the investigations have been made chiefly in large research establishments maintained by manufacturing firms which have employed hundreds of chemists and have persevered for years before achieving results capable of commercial development. In Great Britain, manufacturing chemists, it is stated in the report, "have not appeared willing to use their resources in this manner", the main interests of the larger firms having been in other directions, while the smaller firms have been either unable or unwilling to undertake research of this kind. The report continues, "in these circumstances, the only possibility of securing that this country took its proper part in the matter, in relation to its imperial responsibilities, was a national scheme supported from public funds." A commencement is therefore being made with such a national scheme supported from public funds, for a sum of £30,000 provided by Parliament has been allocated by the Council "for research in chemotherapy, in the first instance in respect of the cost of the new buildings required", and it is stated that such a scheme would attempt to follow with Government support the general line of action of a great commercial organization taking up this subject of research. Presumably the scheme would be under the control of the Council and, so far as is indicated in the report, would operate without the direct co-operation of industry.

It is not clear on what grounds the Council bases its opinion that in existing circumstances the *only* possibility of securing that Great Britain may take its proper part in the matter is such a national scheme supported from public funds. Presumably

* Committee of the Privy Council for Medical Research. Report of the Medical Research Council for the Year 1936–7. (Cmd. 5671.) Pp. 195+xiv. (London: H.M. Stationery Office, 1938.) 3s. net.

one of the grounds is the inference that because, as alleged, manufacturing chemists in this country "have not appeared willing to use their resources [for research] in this manner", they are now and will continue to be unwilling. There is, however, no substantial evidence in the report that the manufacturing chemists either have been or are at present unwilling to use their resources in this manner. On the other hand, evidence from other sources supports the opposite opinion, at least in so far as concerns certain manufacturing chemists, for in 1931 a scheme for the compulsory dedication of patents to the public and their administration by a State department was submitted to the Departmental Committee on the Patents and Designs Acts by a Joint Chemical Committee representing several chemical institutions, and it was stated that the scheme might be regarded as the expression of opinions held in common by most of those concerned in the practice of chemistry in Great Britain. It is clear, therefore, that in 1931 these manufacturing chemists were willing to co-operate, and there is no reason to think that they are less willing to do so to-day; indeed, there is reason to believe from recent statements in the Press that they are not only willing but even anxious to co-operate.

There was, however, opposition to the scheme put forward by the Joint Chemical Committee, and the Departmental Committee reported that although no question considered by it had attracted more attention or been the subject of more conflicting evidence, the definite conclusion had been reached that no sufficient case had been made out for any compulsory dedication.

In view of this definite conclusion and of the lack of evidence to support the circumstances on which the Council bases its opinion as to the only possible scheme, it may be pointed out that there are now in operation in other countries at least two quite different schemes in each of which science and industry are co-operating with one another.

The first is a scheme for the voluntary dedication of medical patents, which is in existence both in Canada and in the United States. In Canada, the ownership of the insulin patent was placed in the hands of the University of Toronto, and has since been efficiently administered by that authority, and in many foundations in the United States there have been drawn up rules regulating the conditions under which patents may be dedicated to them. In the United States, during the past few years, there has been a growing recognition on the part of university administrators that only through the proper use of the patent system can the public benefit of certain of the inventions which are made in their laboratories be ensured and the undesirable aspects of patent exploitation avoided. It is felt in that country that mere publication of a scientific paper disclosing an invention does not prevent patenting of the invention by some individual with a hazy fragmentary prior record along the same general lines. The inventions may easily get into unscrupulous hands and the public may be exploited through this unforeseen result of a programme of institutional research. There is, however, no substantial evidence that opinion among medical men and manufacturing chemists in Great Britain would favour the adoption of a scheme for the voluntary dedication of medical patents.

The second scheme in which science and industry are co-operating is that which has already been established in Germany with such satisfactory results to that country and such unsatisfactory and even dangerous results to our own country. According to the report of the Medical Research Council, the discovery and production of compounds of value in chemotherapy have "depended almost entirely on German science and industry, and still so depend", and in the opinion of the Council the difference between the practice in Germany and the practice in Great Britain is that whereas in Germany large research establishments maintained by manufacturing firms have employed hundreds of chemists and have persevered for years before achieving results capable of commercial development, British manufacturing chemists have not appeared willing to use their resources in this way. There is, however, another important difference, produced by the fact that medical men in Great Britain have not readily given their co-operation to test a therapeutic agent that is the subject of proprietary rights. In the evidence submitted by the Medical Research Council to the Departmental Committee on the Patents and Designs Acts it is stated that:

"There is not there [in Germany] the same feeling against the taking of patents by medical men, and many physicians attached to public hospitals and University Clinics are ready to investigate new remedies on behalf of a commercial patentee, on a footing similar to that of the consulting chemist."

It should be remembered also that manufacturing firms are placed under other serious

limitations in respect of medical patents by the law of this country. For example, by Section 38A of the Patents and Designs Acts, 1907–1932, a medical patent must be of defined limited scope and "the Comptroller shall, unless he sees good reason to the contrary, grant to any person applying for the same, a licence" to use the invention; and again, by the Therapeutic Substances Act, 1925, a scheduled therapeutic substance may be manufactured only under licence, and a Joint Advisory Committee consisting of representatives of the Ministry of Health and medical and scientific bodies fixes the standards of purity, strength, etc.

In view of these facts, it is not clear either that the circumstances alleged by the Medical Research Council have a sufficiently firm foundation on which to base its opinion as to the only possible scheme, or that the scheme proposed is the one most likely to attain the desired end. Is it to be seriously contended that a scheme controlled solely by British science without the aid of British industry will be able to displace German science and industry, working in harmony, from the strong position in chemotherapy which they already hold in Great Britain? Would it not be better in making a forward step to try once again to follow the path which has led Germany to success through willing co-operation between science and industry, than to embark on an uncharted course controlled solely by science without the willing co-operation of industry? The immense responsibilities of the British Empire in tropical countries and the dangerous position of Great Britain in the event of war seem to make it imperative that, before any untried plan is proceeded with, every possible effort should be made by all the parties concerned—scientific men, medical men, and manufacturing chemists—to evolve a scheme of the kind which has already brought success to Germany, whereby the willing co-operation of science and industry will rectify our unsatisfactory peace-time position by rendering the country independent of foreign supplies of chemotherapeutic drugs.

Knowledge and World Progress

World Brain

By H. G. Wells. Pp. xvi+130. (London: Methuen and Co., Ltd., 1938.) 3*s*. 6*d*. net.

THIS, the latest of Mr. Wells's books, may well be the latest-but-one before this review appears, so swift is the rush of his ideas, so urgent the message which he has for a civilization clattering blindly towards chaos. Here, as in so much of his work, we have yet another contribution towards that orderly world-scheme so dear to the heart of the ever-young, wise and keenly interested recruit to the ranks of the septuagenarians. The essays collected in the hundred and thirty pages of this slight and engrossing volume comprise a Friday evening discourse delivered at the Royal Institution, a lecture given in America, a contribution to the Encyclopédie Française, the presidential address to Section L of the British Association on "The Informative Content of Education" and a series of appendices evoked by the comments of those sensitive souls ruffled by the more provocative parts of his addresses.

For provocative Mr. Wells is—and long may he remain so! To some he may, now and then, seem to lay more stress on the material than the spiritual factors that have contributed to the making of history. As when he tells us that "in the middle-nineteenth century all Europe thought that the United States must break up into a lawless confusion. The railway, the printing press, saved that." That is a literal truth. But the mind of Abraham Lincoln, a man as great as some of the strutting leaders of a later age are small, was surely the determining factor in the preservation of the Union.

These divagations, however, are but incidental, and in most of these addresses Mr. Wells seldom wanders far from his main theme—the gathering, indexing, digesting and clarifying of the sum total of present knowledge into an ever-changing, ever-growing World Encyclopædia, which shall not only serve the needs of the specialized student, but also shall give to the citizen of the nation of to-day something of the factual and critical knowledge necessary to make easy his progress towards citizenship of that world-federation to which he is, paradoxically enough, stumbling through a phase of intensified nationalism.

There never was a time in the history of mankind when it was more necessary that this ordered knowledge should be at the beck and call of all of us—when the elements of success are in the hands of those who can combine an emotional drive towards the light with an intellectual appreciation

of the difference between the true and the false dawn.

There's the rub. The two elements must be present and, whereas the emotions are easily, too easily, aroused, it is the hardest task in the world to persuade men to think objectively. In his so-called reasoning on matters directly concerning his relations with his fellows, man for the most part is content to allow a series of fleeting images to pass before his mind. He stamps down those he dislikes, seizes on those that appeal to him and terms the process "coming to a reasoned judgment". The result may be seen in a conversation overheard just after the Austrian coup—a conversation which is, as near as may be, reported *literatim* :

A : "Thank heaven we'd no League of Nations functioning this week-end—we'd have been in the middle of a first-class war now."

B : "Don't you think it would be more accurate to say that if we'd had a League of Nations this situation would never have arisen ?"

A : "Not a bit of it. Anything like the League means that England's left to hold the baby—as we were when Wilson founded his blessed League, and then cleared out and let us down."

B : "Do you really feel that that's an accurate account of what Wilson did ?"

A : "Near enough. Anyway, we disarmed to the bone, to set a good example—and much notice anyone else took of us."

B : "Have you ever drawn curves of arms expenditure year by year to see if there was a dip in British expenditure that wasn't present in that of other countries ?"

A : "No—and I don't intend to. And if there wasn't a dip it was because money was spent in wages that should have been spent on ships."

There was more to the same tune.

And now remember that *A* is a well-to-do and competent man of business, multiply him by some millions, think of his like in other countries, and we see only too clearly that here is an immense mass of material not likely to be influenced in the slightest measure by the content of any World-Encyclopædia.

Not that there is need for despair on this account. Mr. Wells, himself perennially youthful, makes his appeal to youth and to those whose minds have not acquired an incurable wry-neck in the course of the process called education. Every year saved from war is a year gained to this end of education for world-citizenship. But what of the particulars of that education—how, in Rutherford's phrase, to "get on with it" ? In these brilliant and discursive addresses, Mr. Wells has sketched a general plan and has, very reasonably, not condescended to detail. Schemes may be over-elaborated and static on that account. In his own wise words, "If a thing is really to live it should grow, rather than be made." But a start must be made somewhere and somewhen. Is it possible, *now*, to provide John Smith at least with pointers that will direct him to objective, critical and unbiased information concerning—well, concerning a thousand-and-one matters about which he should be conversant—the causes of the world war, the reasons for the great depression, the tragic story of these wasted twenty years, the meaning of money, credit, world-trade, Bolshevism, Communism, Fascism—how many of those whose votes may decide the fate of the world have the beginnings of knowledge of topics bandied about on all political platforms ! If Mr. Wells would continue the good work he has initiated in the volume under review, he would add very sensibly to the heavy debt which the civilized world already owes him.

ALLAN FERGUSON.

Pliny Revived

The Mind of the Ancient World: a Consideration of Pliny's Natural History. By H. N. Wethered. Pp. xv + 302. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1937.) 12*s*. 6*d*. net.

THIS book is a good example of a process which will become more and more necessary as time goes on. There are masses of old literature, full of interest, much read and very important in their day, which it is impossible for us now to read in their entirety, but which it would be a grave loss to let die. Pliny was one of the finest characters of the ancient world, highly cultivated, very busy and useful in public service under his friend the Emperor Vespasian until A.D. 79, when he was suffocated in the eruption of Vesuvius. He gave the greater part of his too short life to incessant study and compiling his "Natural History", or "Survey of Nature", which was an encyclopædia of knowledge and legend about everything in the world of which men talked or had written in his time. This great book, which Humboldt thought surpassed in the richness of its contents any other ancient work, was translated at the beginning of the seventeenth century into delightful Elizabethan English, by Philemon Holland, a few years before Sir Walter Raleigh published his "History of the World".

Both books, famous and much enjoyed in their day, are now almost entirely neglected, and Mr. Wethered has had the happy idea of extracting the gems of Philemon Holland and connecting them by a very well-informed and sufficiently critical running commentary of his own, which gives us all the best of Pliny without allowing us either completely to discredit him or to accept all his amusing fables as gospel truth. The result is a very useful and an extremely interesting book. One's only criticism can be of its main title, for it cannot be said that Pliny's work adequately represents "The Mind of the Ancient World". He was not a serious thinker, but a compiler of everything, writing or gossip, which he came across. A book in which we find none of the philosophy or mathematics of the Greeks cannot properly be said to describe "the mind of the ancient world".

But for what it is—a gossiping encyclopædia of ancient lore—there is nothing comparable. The book is the source of most of the legends and best-known stories of Greece and Rome. Here is Cleopatra's pearl drunk off in a cup of "sharp vinegar" and Polycrates' sardonyx ring brought back to him in the body of a "mighty fish", and the dolphins that waited for the little boys and carried them on their backs and died for grief when they lost them; and a host of others. But it would be a great mistake to dismiss the general picture which Pliny gives us of the ancient world on account of his delightful credulity for interesting stories. Most of them are told just as good stories commonly believed and, though he is not a careful scientific observer, he sometimes intimates a want of credence for certain things. For the bulk of what he described he is as reliable as Herodotus and, of course, far more detailed. Herodotus, the father of history, has a story to tell and the personal and social details are incidental. Pliny sets out to paint a picture of the world and of men as he saw them and is the father of encyclopædists, even, one might say, of 'descriptive sociologists'. We gain from him a realization of the elaborate civilization and luxury of his times which we should not have acquired elsewhere; and he adds to his description a very proper moral indignation at much of what he describes. "What folly and madness in the devil's names is this", is the sort of exclamation which keeps falling from his lips when he describes the doings and the waste of men like Nero, who had just passed away.

Pliny is specially rich and valuable on two sides; one, the full description of plants and vegetables and the use made of them; the other, the work of painters, sculptors and artificers generally. In the former case, one is amazed at the wide and often very intelligent use made of herbs and vegetables by men of all classes. The lettuce was in as much repute as with us, and the cabbage much more so. Eighty-seven different remedies were attributed to the cabbage and scores of others to garlic, onions, asparagus and radish. But it is probably as the source of material information as to painters, sculptors and artificers of all sorts that Pliny has enlightened us most. The Seven Wonders of the World, and many other things still more wonderful as craftsmanship, are described in full and fascinating detail. The sorts of marble and of gems or colours stand out in vivid relief. He does not philosophize about the art but pictures the artists' work and gives the personal anecdotes about them that had been handed down.

On two other sides, if not philosophical, Pliny yet leaves a strong moral impression. One relates to the feelings of men generally in his time, the other to his own religious leanings. There was undoubtedly a much stronger sense for beauty than among ourselves, even in the case of men like Nero who were stained with every crime. Nero was passionately fond of certain gems and colours. Beautiful buildings, statues and decorations aroused far keener admiration in him and all of his time than they do with us. For himself, Pliny leaves us one or two immortal sayings, on the unity of Nature and the nature of the divine. He was no atheist, but he had no moral use for the mass of gods and goddesses of ancient mythology. "These beliefs, I say, are mere fooleries, little better than childish toys. Whereas in very truth a god unto a man is he that helps a man; and this is the true and direct pathway to everlasting glory. (Deus est mortali juvare mortalem, et haec ad aeternam gloriam via.)"

F. S. MARVIN.

Animal Collecting

Animal Treasure

By Ivan T. Sanderson. Pp. 325. (London: Macmillan and Co., Ltd., 1937.) 12*s*. 6*d*. net.

"ANIMAL TREASURE" is not a chronological narrative of a sojourn in the wilderness, although naturally some regard has to be paid to the lapse of time. It is a most readable and lively account of some of the things seen and heard by the author and his two companions during a stay of about eleven months in the forest of the Cameroons and for the most part at a distance of about 250 miles from the coast.

There are many descriptions of the living and frequently unalarmed animals. One must use the

latter qualification, since, for example, the lemur on p. 127 was, if not frightened, very angry, and the entire local mammalian fauna, including all the primates, on pp. 128–131 was suffering from the most diverse and undignified emotions. That Mr. Sanderson is as accomplished with his pencil as his pen is shown by the illustrations, the majority of which are a pleasure to the eye.

Through the liveliness of the text there is allowed to appear hints of the industry by which this expedition brought together a very large and varied collection of the smaller mammals, of reptiles and amphibians and of crustaceans and arachnids.

Mr. Sanderson was evidently on the best of terms with the native population and found them very valuable collectors and preparators. It may be permitted to remark that the taste for chitterlings is not a peculiarity of the Negro race (cf. p. 185). These delicacies are appreciated in the Argentine and the name has been known in English since 1280.

It is rather surprising to find a person with the sophistication which Mr. Sanderson at least suggests that he possesses allowing himself the naivety of attacks on Christians and Europeans. One cannot help feeling that but for these despised creatures the author's experiences from the time of his landing might have been quite different; it is surely a little ungrateful. But it is verging on impropriety for a professing man of science to regard any animal with the emotions Mr. Sanderson seems to feel for spiders, shrews and hawks. It is not the duty of a collector to kill and waste: the persistent killing of the hawks can have no excuse.

Mr. Sanderson, as a schoolboy, was disappointed in the old methods of collecting, but he does not clearly describe a new one. His own do not appear to have been particularly original, and it may reasonably be concluded that they were those which are in general use.

It may well be that the publishers have exceeded the author's intention by describing the book as "among the serious works of science" on the back of the jacket. This it certainly is not. Some of the statements have been seriously challenged by Mr. Arthur Loveridge in the *Scientific Monthly* of January 1938, and even if he is refuted, the fact remains that the zoological parts are so mixed up with general narrative and discourse as entirely to avert the idea of seriousness, and there is not even an index to enable the grain to be separated.

It will be interesting to see what new facts appear from Mr. Sanderson's field note-books in the reports on the collection which will doubtless be published.

Although there may be species of such rarity that examples of them would be welcome even if almost devoid of data, the idea of a new sort of collecting is an attractive one and may be considered in a little detail. A moment's consideration will show that what is really wanted is a strong effort in the field to fill in the gaps not only in the dead series in museums but also in our knowledge of the animal "in his habit as he lived". It is, of course, an ideal probably unattainable to expect that a complete picture can be made for every species, but if the field worker could find out beforehand what forms should be the objects of special concentration, much might be done. What is wanted is not only a long series of specimens of both sexes and all ages from which it can be shown what occurs in the way of growth and change and individual variation: with this should be coupled descriptions of the animal in life, even, if it is soft bodied, including its shape and of part at least of its physiology, not quite in the text-book meaning but with regard to the two survival functions, that of the individual—feeding and protection from destruction, and that of the race—method, time and place of breeding. With these might be linked observations on behaviour; not the reaction of the animal to interference, which is easily seen in the laboratory, but the manner in which it goes about its business and reacts to the stimuli provided by its environment. From such knowledge one may hope, for example, to be able to recognize apparent eccentricities of distribution in time or space as normal features of the routine of species. Further, is it inconceivable that some of the obscure problems of phylogeny might be illuminated by a study of the living creature? If descent show itself in hard or soft tissues, is it too much to expect that it will also be exhibited in the way in which they function?

It is possible that data exist for such 'descriptions' but they are seldom met, although in ornithology and entomology the tendency towards them exists. Specialists innumerable are constantly adding to the existing vast mass of knowledge, but they too seldom unite with a common goal in mind.

Some kind of intelligence, in the military sense of the word, is needed. It should be the function of a section of zoologists to correlate the information produced by the specialists. Although there may be a million species known, so that the first view of the task is appalling, the scientific spirit does not shrink on account of the magnitude of what lies before it, if the thing has to be done. In darker moments it seems that only by a union with the work of the field naturalist can zoology be saved from becoming a synonym for necrology, if one may introduce a new meaning for that word.

J. E. HAMILTON.

Social Anthropology of North American Tribes: Essays in Social Organization, Law and Religion. Presented to Prof. A. R. Radcliffe-Brown upon the occasion of his accepting the Chair of Social Anthropology at Oxford University. By Fred Eggan, William H. Gilbert, jun., J. Gilbert McAllister, Philleo Nash, Morris E. Opler, John H. Provinse, Sol Tax. Fred Eggan, editor. With an Introduction by Robert Redfield and a Bibliography of Prof. Radcliffe-Brown by Ina Corinne Brown. Pp. xvii+456. (Chicago: University of Chicago Press; London: Cambridge University Press, 1937.) 13*s.* 6*d.* net.

THE announcement of the departure of Prof. A. R. Radcliffe-Brown from the University of Chicago to become the first professor of social anthropology at Oxford inspired certain of his pupils to produce this volume, commemorating his work for the study of social anthropology in the United States during the past five years.

As his colleague Dr. Robert Bedfield reminds us in an introductory appreciation, Prof. Radcliffe-Brown's theories of the method of social anthropology have become something of a storm centre in the United States. They aim at a scientific sociological methodology on the lines laid down in his presidential address to the Anthropological Section of the British Association at its London meeting, in contradistinction to the 'historical' view which has grown out of methods followed by Franz Boas, and the individualistic and psychological methods of E. Sapir and Margaret Mead. Hence this volume is something of both a demonstration and a manifesto. It certainly contains some interesting experiments in method which form a striking contrast to those familiar in the writings of American social anthropologists, and, furthermore, had already been applied to some of the material reviewed here.

Of the essays included in the volume—nine in all—perhaps the most instructive from the point of view of the student of method is that on "Some Problems of Social Organization" by Dr. Sol Tax. The author, after setting out some of the more general questions, for which it is the aim of social anthropology to provide a solution, attacks the kinship terminology of certain Indian tribes of California, who follow the so-called "Omaha" and "Crow" systems respectively. It is interesting to note, however, that in arriving at his conclusions as to the place of these systems as determinants in organization and behaviour, he felt constrained to depart so far from his teachers' strictly sociological concepts as to admit psychological factors.

Glossary of Physics
Compiled and edited by Prof. LeRoy D. Weld, with the collaboration of a large group of Consultant Physicists. Pp. x+255. (New York and London: McGraw-Hill Book Co., Inc., 1937.) 15*s.*

THE rapid development of physics during recent years has, of necessity, required a very large addition to its vocabulary. In reading the literature of a particular branch of the subject in which one has not specialized, one comes across unfamiliar terms; in such instances to have an accurate glossary to hand is of the greatest use. Prof. Weld and his collaborators deserve the warmest thanks for providing such a glossary. We can well believe that it was "impracticable to make sure of complete agreement among the various persons concerned on each of the many definitions and statements"; but although perhaps a few experts may not favour a definition here and there, the vast majority of physicists and those concerned with its manifold applications will find this an indispensable volume. A pleasing feature of the book is the inclusion of references in connexion with most of the terms, which enable the reader to gain supplementary information.

The book is well arranged and produced, and of convenient size; we hope that the demand for it will justify the issue of future editions at a price that the average physicist is more likely to be able to afford. H. R. L.

The Theory of Continuous Structures and Arches
By Prof. Charles M. Spofford. Pp. xiii+267+12 plates. (New York and London: McGraw-Hill Book Co. Inc., 1937.) 21*s.*

THE first chapter of this book deals with continuous structures, and the last is devoted to rigid frames. Apart from these, the text is mainly concerned with arch types, and the applications of the methods of arch analysis to bridge forms. The usual lines of theory are developed effectively. Applications are made with thoroughness and with an explanatory power and detail of evaluation that demonstrate a full knowledge of the problems of design of this class. Two-hinged arches of parabola and segmental types receive very full attention and the treatment of fixed arches is adequate in scope. There is an interesting presentation of the results of photo-electric researches on rigid frame forms and some instructive plates of bridge construction.

Although the treatment is somewhat less wide in scope than the title, the book is well planned and developed for advanced students of bridge theory and design.

Grundriss der allgemeinen Zoologie
Von Prof. Dr. Alfred Kühn. Fünfte, verbesserte und vermehrte Auflage. Pp. ix+272. (Leipzig: Georg Thieme, 1936.) 9.80 gold marks.

FORMER editions of this excellent text-book, with its comprehensive and well-balanced contents and clear illustrations, have been favourably noticed in NATURE (112, 200; 1923: 129, 925; 1932). It need only be added that many changes in the text show that the fifth edition has been brought up to date. In some places, precision has been given to the already succinct descriptions of the characters of phyla, the section on development has been modified to meet modern views, and a short chapter upon the ecological distribution of animals includes a discussion upon the relationship of species in parasitism and symbiosis. We think it may still be said that there is no English book quite like this introduction in the success with which it lays, in so limited a space, a broad foundation in the morphology, physiology and development of the animal kingdom.

Gliding and Soaring Flight*

By Prof. D. Brunt

THE early history of gliding is the early history of flying in heavier-than-air machines of any kind. The machine was projected into the air either from a hill-top or from flat ground, and came down slowly while moving forward. Lilienthal described in his book on "Bird Flight as the Basis for Aviation" how in some of his earlier experiments in gliding over slopes the machine actually soared, or gained in height, being carried upward by the air current flowing up the slope. But the early pioneers soon became absorbed in the problem of developing a power unit, and the development of the petrol engine, by making the aeroplane possible, diverted attention from the possibilities of pure gliding. In Germany gliding was taken up as a sport soon after the Great War, and in 1922 the achievement of Martens in soaring for an hour gave a new impetus to the movement. The *Daily Mail* organized a gliding meeting at Itford Hill in 1922; but this failed to produce any permanent interest in gliding in England. It was only at the end of 1929, after the Germans had shown that the glider need not be bound to a hill-slope, but could soar under and into clouds, and could ride the front of an advancing storm, that interest was at last aroused in Great Britain, and that there came into existence a real British gliding movement. After undergoing the usual pangs of adolescence, this movement is now approaching the adult stage.

There has not been any very revolutionary change in the design of sailplanes in recent years, and it may be said that in appearance the modern sailplane resembles the power monoplane, without an engine, but with a more closely streamlined form. Differences occur in the wing-structures used, the strutted wing being generally lighter than the cantilever wing. Perhaps the most important change made in recent years has been in the direction of increasing the strength of the structure, in order to make it capable of standing the strains to which it may be subjected during flight in clouds. The stoutness of the fuselage is dictated, not by the demands of flight, but by the necessity of the structure being able to stand up to the strain of handling when on the ground.

In the early stages of training, the machine is launched by means of an elastic catapult, the ends being drawn by teams of men. Alternatively, the human power may be replaced by a horse or motor-car. Another method is to attach a cable to the front of the machine, and to wind it rapidly on a winch, thereby dragging the machine into the air, while another method is to tow the machine into the air behind an aeroplane. Sailplanes can fly at very low speeds without stalling, and consequently can be landed with safety in fairly small fields.

The modern sailplane has a sinking speed in still air of about 2–3 ft. per second, and so will soar in any vertical current the vertical component of which exceeds this modest value. The pilot of a soaring sailplane is in the position of an old lady trying to go down the up-escalator at a tube station, the escalator carrying her up faster than she can descend the steps.

For our present purpose we can define the problem of soaring flight as the problem of finding upward air currents of the necessary magnitude, that is, exceeding the sinking speed of the sailplane in still air, usually 2–3 ft. per second. For practical purposes, we can say that there are three classes of ascending currents in the atmosphere. First, when the wind blows against rising ground, it follows the contours of the ground, and if the upward component of the wind is sufficiently strong, soaring will be possible over the sloping ground. Secondly, when the air is unstable, convection currents may attain sufficient speed to make soaring possible. Thirdly, at the cold front in a depression, where a wedge of cold air pushes under a warm current, there is often sufficiently rapid ascent of the warm air to make soaring possible. Sometimes thunderstorms occur at cold fronts, and long flights have been achieved in the ascending currents in thunderstorms.

When the wind blows up the side of a hill the horizontal flow of the air is disturbed up to a height of about three times the height of the hill. A sailplane launched into the ascending current from the top of the hill can, by circling in the ascending current, attain a considerable height. If the pilot's aim is to make a flight of long duration, he can go to and fro above the ridge of the hill, and the duration of his flight is limited only by the duration of the wind in direction and strength, the pilot's physical endurance, or possibly the dangers of darkness. During the 1937 international competitions, two members of the English team, Messrs. Fox and Murray, flying the Falcon III two-seater, made a duration flight of 9 hours 48 minutes.

*Friday evening discourse delivered at the Royal Institution on March 5.

Long-distance flights cannot be made by hill soaring alone, but even when long-distance flights are attempted, they usually start with a gain of height over a slope, and on the way across country any slopes facing into the wind direction may be used to maintain or increase height, while the pilot waits for other types of ascending currents to turn up.

Fig. 2.

THE SAILPLANE *Hjordis* WHICH FLEW 104 MILES ON JULY 5, 1936.

The second type of ascending current, the convection current, occurs when the air is unstable, that is, top-heavy. Instability in the atmosphere requires a rate of decrease of temperature with height in excess of 5·6° F. per 1,000 ft. When this limit is surpassed, as is frequently the case when the sun is shining, and particularly on bright afternoons, convection currents (or 'thermals', to give them the name usually applied by the gliding men) are set up. Every convection current which carries warm air upward must be compensated by a descent of air somewhere. In other words, convection currents must possess some kind of structure.

In the laboratory it is easy to set up convection currents in a liquid or in a gas. The simplest illustration is afforded by pouring cheap gold paint into a shallow tray such as a mince-pie tray. The evaporation of the volatile liquid cools the upper layers, and so makes the liquid top-heavy. Looked at from above, the liquid is seen to be divided into a number of small cells, in each of which the liquid ascends at the centre, flows outward over the upper boundary, and descends at the margin of the cell. Similar effects can be readily produced in air. A convenient chamber for such experiments with air has a metal base, which can be heated electrically from below, and a glass top through which the motion can be observed, the motion being made visible by tobacco smoke. Such experiments may be regarded as reproducing conditions similar to those in the atmosphere when there is no wind. To simulate the effects of wind varying with height, the top glass plate must be capable of being moved across the chamber, dragging the air with it. It is then found that, if the instability is great, the bottom of the chamber being considerably warmer than the top, a slow motion of the top plate only distorts the shape of the cells obtained previously. If the bottom plate is not much warmer than the top plate, a slow motion of the top plate gives long rolls at right angles to the direction of motion of the plate. Such rolls are called transverse rolls. When the top plate is moved rapidly, the chamber is filled with long rolls in the direction of motion of the plate, and these are known as longitudinal rolls. The rolls, whether longitudinal or transverse, are in pairs, the two rolls in a pair

Fig. 1.

CUMULUS CLOUD CONSISTING OF A SERIES OF CUMULI JOINED UP IN ROWS.

spinning in opposite directions. Thus, when in the atmosphere conditions are unstable, the rolls of cloud formed by the upward motion of damp air will be at right angles to the wind if the wind speed varies only slowly with height, but along the wind direction if the wind speed varies rapidly with height. When damp air rises through a sufficient range of height, it produces cloud, and the cloud may be taken as an indication of the existence of the ascending current. If the wind does not vary with height, or if there is a calm, the clouds will usually be cumulus clouds, each forming the cap of an ascending current. When the wind increases rapidly with height, the cumulus clouds will form long irregular rolls (Fig. 1). Under any of these clouds the soaring pilot can find an ascending current, and under the long streaks of cumulus he can go the whole length of the cloud almost as readily as a car can go along a road. For this reason, such long cumulus clouds are generally known as 'cloud streets'.

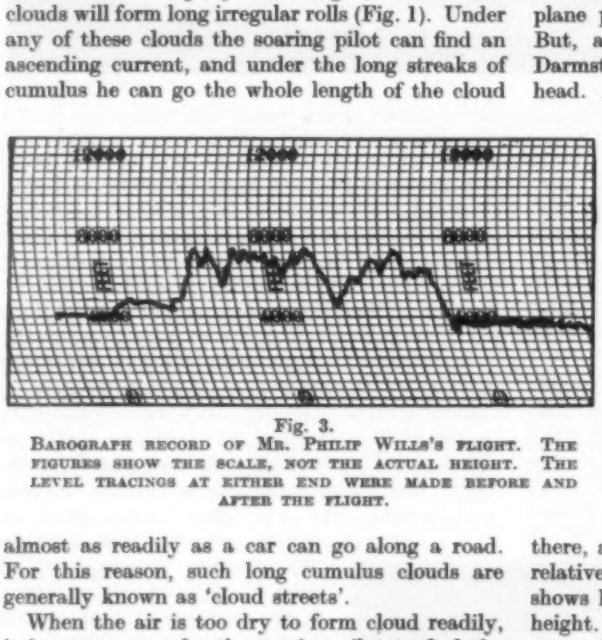

Fig. 3.
BAROGRAPH RECORD OF MR. PHILIP WILLS'S FLIGHT. THE FIGURES SHOW THE SCALE, NOT THE ACTUAL HEIGHT. THE LEVEL TRACINGS AT EITHER END WERE MADE BEFORE AND AFTER THE FLIGHT.

When the air is too dry to form cloud readily, it is not so easy for the soaring pilot to find the ascending currents. He then has to consider what types of ground are most readily heated by the sun, since it will be over the hottest ground that the ascending currents will form. Now it is possible to arrange types of ground in order of readiness with which they will heat up in the sun, as follows: sand, light soil over chalk, light loam, heavy loam, clay, water-logged soil, water. Any type of soil will heat up more readily when dry than when wet, more readily when bare than when grass-covered. The roofs of houses are heated more than grass fields, and the air trapped between the stalks of corn will be heated more than the freer air over a meadow. The air in woods will remain warm longer than air outside them, when the sun is low. Thus on a sunny day the pilot will look for thermals over villages, over large buildings, over any sandy or chalky patch surrounded by heavier soil, over cornfields surrounded by meadows. He will sometimes find thermals over land near the edge of any large body of water, and an asphalt road, which can heat up in the sun to as much as 25° F. warmer than surrounding fields, will very readily become a source of thermals when the sun shines on it. In the evening, thick woods on the side of a hill will produce thermals by the release of the warm air trapped within them during the day. Then the pilot will in the course of time find that there are certain spots in the neighbourhood of his usual soaring ground at which thermals are frequently formed.

Thus even in the absence of clouds, the sailplane pilot has certain principles to guide him. But, as Kronfeld once stated in a lecture at Darmstadt, the soaring pilot must fly with his head. By so doing he finds the thermal he needs. When once he gets into a thermal he can circle round in it until he has gained as much height as possible, during which time he will drift down with the wind. Alternatively, he can fly fast when he finds no ascending current, and slow down the moment he finds himself ascending, so as to gain as much height as possible in the ascending current.

As an example of what can be achieved, first consider that flight by Mr. Philip Wills on July 5, 1936, which holds the British distance record of 104 miles [see p. 745]. This flight was made in the sailplane *Hjordis* illustrated in Fig. 2. During the afternoon the sky showed scattered clouds, with short cloud streets here and there, a mile or two long and in series staggered relative to each other. The barograph chart (Fig. 3) shows how the pilot had to struggle to maintain height. The cloud base was very constant, at a height of about 3,600 ft., and so the pilot could never afford to lose much height. The lowest point on the chart, showing a height of about 400 ft. above the height of launch at Dunstable, and a height of about 800 ft. above the ground then immediately below, appeared to make a landing imminent, but at the critical moment a slight lift was found, and in 15 minutes the sailplane had gained 2,000 ft. This is an example of a flight made by circling in thermals, and staying in them as long as height was being gained.

The weather chart on that day showed no special indication that convection would be unusually active. There appear to be relatively few days on which it would be impossible for a sailplane to make a flight, if once it had achieved sufficient height to be able to wait for thermals to turn up. Distance flights are rarer than they need be in England because most of the soaring sites from

which a start can be made have their soaring slopes facing westward into the prevailing wind, and so a start cannot be readily made when the wind is not westerly. Longer flights could frequently be achieved if the start were made by aero-towing.

The alternative to circling in thermals, variation of speed so as to go slowly in thermals, and fast when out of them, is exemplified by the flight from Berlin to Kiel, carried out by Ludwig Rotter on August 12, 1936. Rotter's sailplane, the *Nemere*, which has a sinking speed in still air of only 2 ft. per second, can fly at 87 miles per hour. During nearly the whole of the flight, the speed was maintained at 75–87 m.p.h., being reduced to 37 m.p.h. when flying through thermals. It was only in the later stages of the flight that the pilot did any circling in thermals. There was little cloud in the sky, but Rotter's barograph record shows that he was never in much danger of having to land from the time he was launched by aeroplane tow at a height of 1565 ft. The distance achieved was 203 miles, and the landing point was 138 miles off the direct line of the wind from Berlin. This flight illustrates the ability of a sailplane to travel across wind. Within the limits allowed by the strength of the machine, a sailplane can travel at any speed by gliding downward at a sufficiently steep angle. Thus by sacrificing height it can even travel against the wind, but it is not possible to achieve any considerable distance against the wind unless ascending currents are frequent and vigorous.

During a flight in South Africa, Mr. Philip Wills found that at times the convection currents were astonishingly vigorous, on one flight a height of 5400 ft. being gained in less than seven minutes. Wills has described how he shared thermals with the vultures, who treated him as one of themselves, flying in formation with him. It appears that the vultures partition the ground, each bird taking a territory of about a half-mile square, and that their existence is devoted to the search for two things, ascending currents, and food on the ground.

There remains to be discussed the third type of ascending current in the atmosphere, at the cold front in a depression. The Norwegian scheme of the anatomy of a depression shows on the weather chart a warm sector, separated from the cold air in the rear of the depression by a line which is known as the 'cold front'. This line is simply the intersection with the earth's surface of the upper boundary of the cold air, which lies in the form of a wedge with its nose some distance above the ground. The cold air pushes under the warm air, and forces it to rise over the nose, and, in some depressions at least, some of the warm air becomes unstable, so that it then rises freely to great heights, often giving a cloud which extends as high as 20,000 ft. The ascending current is often sufficiently vigorous to lift a sailplane to great heights, and once a sailplane has got into this current, it can fly along the direction of the front while being carried along with the front in its drift across country. Some remarkable flights have been achieved in this way.

We may note in passing that the fact that gliding is possible at a cold front, at heights of many thousands of feet, throws some light on the meteorology of the cold front. The slope of the upper boundary of the cold air averages about 1 in 50, and since we may assume that the ascending current must mount at a rate of at least 5 ft. per second if a sailplane is to gain height at a reasonable rate, it follows that if the ascending air were merely flowing up the slope of the upper boundary of the cold air, it would have a speed of 250 ft. per second, or about 166 m.p.h. This is far in excess of the winds in which cold front flights have been carried out, and so we may conclude that the ascending currents in which the flights were made were not due to ascent up the slope of the wedge. An examination of upper air temperatures measured just in advance of the cold front has shown that in some depressions the air is in such a state that if pushed upward through a relatively small distance, it will then rise freely.

When a sailplane pilot soars into the ascending currents below cumulus clouds, or near a cold front, he does not always find it easy to go just where he wishes. He is frequently drawn into the cloud, whether he wishes to enter it or not. Inside a cloud the air currents are frequently very irregular and violent, and the machine needs to be stoutly built if it is to stand this rough treatment. Further, the machine must then be piloted by the use of instruments which show any deviation from the horizontal, otherwise there is a risk of its coming out of the cloud in a nose-dive, or even upside down.

During the 1937 international competitions in Germany an English pilot, Flight Lieut. Watt, achieved a gain of height of 8,000 ft. in a cloud, taking about one and a half hours to do so. This is probably the best achievement in cloud flying which stands to the credit of a British sailplane pilot. Cloud flying has for some years been part of the normal advanced training of German pilots, but in Great Britain it is a recent development.

In Great Britain, gliding and soaring flight is purely a sport, while in Germany and Poland it is part of the normal early training of the power-plane pilot. In the latter countries, gliding and soaring flight is highly organized. It is perhaps invidious to make a direct comparison between the achievements of British and Continental sailplane pilots. The longer period during which gliding has been organized in Germany and other Continental

countries, added to the fact that far stronger financial support is given by the Government in these countries than in Great Britain, makes a direct comparison at the present time a little unfair to British gliding. A comparison of distances achieved is particularly misleading, since Great Britain is, after all, a small country. For example, starting from Dunstable with a westerly or south-westerly wind, it is impossible to outdistance Wills's record flight of 104 miles by more than a few miles at most. At the international competitions last year, out of 297 launches for distance flights forty flights exceeded 100 miles; on the first day of the competitions three competitors flew from the Wasserkuppe to Hamburg, a distance of 351 kilometres (218 miles). Again, at the Polish National Competitions in 1937, the distance flights *averaged* more than 60 miles, the longest flight being nearly 200 miles. These competitions were held in the flat country in the north-west of Poland, in order to test the possibilities of soaring in flat country with launching by aero-towing up to heights of 1600–2000 ft.

The world's distance record for cross-country soaring is held by a Russian pilot, Rastorguyev, who set up three new records consecutively, of 335, 374 and 405 miles, all made during May 1937.

Enough has been said to show that long-distance flights can be made in sailplanes without serious difficulty. Gliding is a safe and healthy sport, and forms a useful preparation for training in power-plane flying. It also offers a means of adding to our knowledge of the processes of convection in the atmosphere, the glider being the only instrument which can be used for a thorough investigation of convection currents. While this may not help in the problem of forecasting to-morrow's weather, it is difficult to believe that increased knowledge will not eventually lead to increased wisdom.

Science, Logic and Philosophy*

By Dr. Harold Jeffreys, F.R.S.

So long as an idealist confines himself to the description of sensations and to the construction of his ideal world, he can dispense with the theory of probability, but at the cost of having to reconstruct his world with every observation that does not happen to fit his laws exactly. An idealist that does not accept the theory of probability could expect the sun to rise in the west to-morrow, and nobody believing otherwise could make the slightest contact with him such as could alter his opinion. But he has no basis for inferring new sensations without it, because an infinite number of laws can always be made to fit any finite number of data. Without some rule for selecting the most suitable laws there is no reason to prefer any one prediction to any other, whether one is an idealist or a realist.

The naive realist is in an even worse position, because his strict causality leaves him with no margin of uncertainty at all; any random variation must either lead to a complete reconstruction of the laws, to a causal theory to account for the random variation itself, or to abandonment of science altogether. The first and third alternatives are seldom adopted; and the second merely points to some hypothetical causes as explanation—which is no explanation at all ([1], pp. 244–248).

*Continued from p. 676.

I conclude that naive realism as a scientific philosophy is simply wrong because it will not work in practice. It requires that we should know everything before we can say anything. Idealism and critical realism will work; the latter demands the notion of probability in any case; idealism also requires it if any inferences beyond the original data are to be made. Accepting the theory of probability, we can test the need to introduce any new parameter by comparison with the observations. The theory therefore gives an account of the actual process of successive approximation, the outstanding variation at any stage being taken as random until there is evidence to the contrary. This variation is as essential a part of the law as the systematic part. Thus we have the statement of Ockham's razor, in the form: Variation is to be taken as random until the contrary is shown*. This is the form needed for scientific purposes*.

The term 'unobservable', discussed in Prof. Dingle's recent article[2], is itself a legacy from naive realism. An observation, strictly, is only a

* It incidentally solves the problem of "scientific caution". Everybody agrees about the need for caution; but people differ about what caution means. Granting the possibility of inference from experience in any circumstances at all, we must begin with the hypothesis of randomness and test successive possible modifications of it. It is sometimes said that it is dangerous to apply a law far beyond the original data; but that is the best possible way to find out whether any modification is needed.

sensation. Nobody means that we should reject everything but sensations. But as soon as we go beyond sensation we are making inferences. When we say that we observe an object we mean that we have, or have had, a series of sensations that are co-ordinated by imagining or postulating an object with assigned properties. The acceptance of a concept with its properties depends on the verification of the inferences that it leads to; that is, it is required that our sensations with it would be different from those without it. Hence the verifiable content of the hypothesis reduces simply to one or more new parameters in a law. This is dealt with completely by the theory of probability, and for purposes of inference nothing more is needed than the law itself. If we restrict ourselves to the inference of future sensations, the concept has done its work and serves no other purpose. This would be a possible idealist attitude. If we are realists and think that our concepts have something to do with an observable world (subject to the critical realist's willingness to change his mind if necessary) we may consider the law as a justification of the reality of the concept. But observability of a concept can mean nothing but the statement that the new parameters suggested by it are significantly different from those without it. Thus the theory of probability takes the rejection of unobservables in its stride. It gives an answer to the question whether any parameter is more probably present than not, given the actual data. To consider further data that we have not is mere waste of time. We need not say that so-and-so *must be unobservable*; we say that in fact, with the data at present at our disposal, it *is unobserved*, and that if we try to take it into account we shall probably lose accuracy.

We now come to the alleged use of the principle of the rejection of unobservables in relativity and in quantum theory. Relativity (up to 1920 or so, at any rate) did not involve any new parameters; the velocity of light, the constant of gravitation, the mass of the sun and so on were all required by previous theories. It made changes in the laws but left them expressed in terms of the same parameters. The reason for abandoning the old theory was not that it involved unobservables such as absolute velocity or simultaneity; it was that this theory made positive predictions that turned out to be in disagreement with observation. The rejection of absolute velocity was not *a priori*, whatever later writers may have maintained; what was done in the special theory was to alter the laws of measurement and light so that they would agree with observation. The general theory, in its original form, was obtained by a natural analogy with Newtonian dynamics. The coefficients g_{ij} were seen to play the part of the Newtonian potential U. Far from matter all second derivatives of the latter vanish; near to matter the contracted Cartesian tensor $\nabla^2 U$ vanishes, but the separate components do not; inside matter $\nabla^2 U$ does not vanish.

Einstein proceeded by analogy. He found a second-order tensor that should vanish far from matter, contracted it to get the differential equations satisfied near matter, and said that these equations will not hold inside matter. Given, what was already established, that the Euclid-Newton system needed modification, this was the natural procedure to try. But it goes straight to the laws connecting measures; there was no philosophical necessity about it. The correctness of the law does not depend on any *a priori* arguments, which merely showed that it was worth considering, but on the fact that it required no new parameters and gave agreement with observation where the previous one failed (apart from one discrepancy, the node of Venus, which seems inexplicable by either theory). Insistence on the alleged philosophical grounds for the theory has led to their being challenged, and it has been a tragedy that arguments about a wholly imaginary philosophical basis have led to almost total neglect of the observational basis. The latter is, in fact, appreciably stronger than is provided by the mere verification, as I showed in Chapters vii–ix of "Scientific Inference". Starting entirely from observed data and proceeding by generalization of laws, introducing new parameters only when observation showed them to be necessary, I showed that it was possible by successive approximation to build up Euclidean mensuration, Newtonian dynamics, and the special and general theories of relativity; and that the form of the Einsteinian ds^2 is completely determined near the sun by observation alone. No further hypothesis is needed, and some of those made by Einstein are replaced by others more closely related to laws already adopted or by experimental facts. The object of the work was to see whether the observed agreement could be regarded as accidental; that is, whether any other possible laws could have given the same inferences in the range of magnitudes available; and it was found that any other form would require the introduction of an enormous coefficient as a new parameter. So far as any law can be proved by observation, Einstein's law is proved within the solar system.

The rejection of unobservables in the quantum theory, so far as I can understand it, seems to be merely a spring-cleaning. The older theories here involved many unobservable quantities, and left many observable ones unco-ordinated. It was apparently impossible to see the wood for the trees on account of the complication of the concepts,

and some of the postulates were certainly wrong, since they led to conclusions inconsistent with observation. The modern quantum theories have begun by direct and successful attempts to co-ordinate what we know, without attending to the details of any deeper interpretation, and as a matter of method I think that their procedure is right. I should disagree, however, with the elevation of the rejection of unobservables into a magic philosophical principle. I do not claim any special credit for the fact that I tidy my room up when I begin to have difficulties in finding things; and in the quantum theory the important forward step did not come from the rejection of unobservables but from the subsequent recognition of formal relations. The relations are not inferred from a principle that so-and-so must be unobservable (and indeed they contain new unobservables of their own, which have to be eliminated before anything verifiable is reached), but are guessed by analogy and asserted because their consequences agree with observation, just like Einstein's law of gravitation. Here, however, the difficulty that I thought worth investigating in the latter is actively present, since different quantum theories at present do give the same observable results.

In this theory, the uncertainty principle has no sensational importance. It merely fixes a lower limit to the uncertainty that we should have with the most accurate types of observation that modern physics suggests; anybody not already blinded to the facts by naive realism and traditional deductive logic would have known that there is no such thing as a quantitative law that fits observations with absolute accuracy. The Heisenberg uncertainty is no new discovery in principle, but an estimate of a lower limit to the old uncertainty, which was never neglected except by misplaced optimism.

Many biologists speak respectfully of determinism, apparently because physicists do. One might have expected the nature of their data to save them from this. I think, however, that they have confused determinism with the possibility of making inferences at all; the test of a hypothesis in biology as in physics is the improvement of approximation, and the theory of probability is equally available for this purpose.

The theory of probability thus enables us to solve many of the major problems of scientific method, which are beyond the scope of traditional logic. It gives a formal account of the actual process of learning; it makes it possible to test laws by observation without making either the unnecessary assumption that laws can be found to fit observations exactly, or the certainly false one that the laws known to us at present do; it solves the problem of the rejection of unobservables; and it removes the paradoxical appearance of the uncertainty principle. It also provides an answer to the difficulty of the excluded middle, that is, that an unconsidered hypothesis may be the true one. When a law has been applied to a large body of data without any systematic discrepancy being detected, it leads to the result that the probability of a further inference from the law approaches certainty whether the law is true or not. In the usual language this would mean that the 'true' law differs so little from the adopted one that the two have been indistinguishable hitherto, and therefore will probably continue to be indistinguishable; thus the adopted one will probably continue to give correct inferences with the uncertainty stated in it. The better the verification of a law, the harder it will be to think of a valid alternative. The theory therefore makes it possible to modify a law that has stood criticism for centuries without the need to suppose that its originator and his followers were useless blunderers. At the same time it gives an answer to the problem of 'scientific caution'; this is best achieved by asserting no more parameters than are found significant, stating the results with the uncertainty found from the observations, and applying the law as far as possible beyond the original data (still allowing for the uncertainty of its parameters) until a discrepancy is revealed, if ever. It admits the whole of human experience as valid data, and any clearly stated hypothesis is worth testing. If the tests are found to reveal significant differences between people, it is still possible to proceed to study these differences and compare them with other data; psychology is admitted as a legitimate science.

We now return to the question of realism versus idealism; all the above considerations are applicable whichever we adopt. My belief in other people's personalities appears to be a generalization from experience of the usual type, and it leads to inferences about their behaviour, so many of which are confirmed that the natural procedure is to accept the existence as genuine while possibly proceeding to study the differences. In the question discussed at the beginning of this article I should say that the realist is definitely right. The belief in a material world is on a different footing, since while I seem to be immediately aware of my own personality, any object, even my own body, is known to me only through sensations. If I was an idealist I should say that I had invented it to give an account of my sensations; as I am a realist I think that I mean something more than that, but I admit that I find it very difficult to say what. In studying seismology I definitely believe that I am finding out something about the interior of the earth and not merely making

predictions about future observations. But in either case the rival hypotheses could be tested only through the sensations predicted from them, and these by construction are identical. Thus apparently the theory of probability makes no decision whatever between critical realism and critical idealism, if the latter is taken as admitting other personalities; both are legitimate hypotheses with probability $\frac{1}{2}$, and I can see no type of evidence that could alter this. I am speaking, of course, of the definite idealism that says that the world *is* nothing but an invention; the indefinite idealism that merely says that it *may* be is the statement 'either definite idealism or realism is true', and cannot be used to deny realism. In any case it does not make the slightest practical difference which we adopt.

[1] Jeffreys, "Scientific Inference", 1937.
[2] Jeffreys, *Proc. Roy. Soc.*, A, **162**, 490 (1937).
[3] Dingle, NATURE, **141**, 21–28 (1938).

Cambridge Meeting of the British Association

THERE can be no doubt that the British Association, adaptable though it is to various environments, is most at home in an academic setting. This year's meeting in Cambridge ought, therefore, to be unusually happy, and the preliminary programme just issued affords prospects of this by more than one implication. Thirteen of the colleges—in addition to Emmanuel, where the secretariat will be housed—offer men the chance to return for a short space to the pleasures of college life; Cheshunt College will be open for women, and other houses (including Girton) will accommodate both sexes. In addition to the University reception in the Senate House and Old Schools, conversaziones, pleasantly specified as 'informal', are announced in Trinity and St. John's, and the Mayor and Mayoress of Cambridge must surely be introducing a new and welcome feature into British Association programmes by inviting members to a sherry party, to be held in Emmanuel. It is to be hoped that the unusually early date of the meeting, August 17–24, dictated as it is by the convenience of the colleges and other authorities, will not dismay any of those who contemplate being present: it may be recalled in this connexion that the last Cambridge meeting, in 1904, took place at exactly the same time, but had nevertheless an attendance of 2,789, a figure far above the average for that period.

The presidential address, by Lord Rayleigh, will deal with "Natural Vision aided by Science", and a few lines which indicate its content may be quoted as an unusual but arresting feature in the programme. "The address," it is stated, "will show how, taking the eye as a prototype, most of the observational methods of modern science may be regarded as derived from it by successive modifications. A further part of the Address will deal with science and warfare, and will be directed to show that the relation between them is of the nature of an accidental by-product, and has in no sense been the primary goal of investigation."

The subjects of sectional presidents' addresses are announced as follows:

Section A (Mathematical and Physical Sciences): Dr. C. G. Darwin, "Fundamentals in Physical Theory"; Section B (Chemistry): Prof. C. S. Gibson, "Recent Investigations in the Chemistry of Gold"; Section C (Geology): Prof. H. H. Swinnerton, "Development and Evolution"; Section D (Zoology): Dr. S. W. Kemp, "The Future Development of Oceanography; Section E (Geography): Prof. T. Griffith Taylor, "Correlations and Culture, a Study of Technique"; Section F (Economics): Mr. R. F. Harrod, "Scope and Methods of Economics"; Section G (Engineering): Prof. R. V. Southwell, "The Changing Outlook of Engineering Science"; Section H (Anthropology): Prof. V. Gordon Childe, "The Orient and Europe"; Section J (Psychology): Dr. R. H. Thouless, "Eye and Brain as Factors in Visual Perception"; Section K (Botany): Prof. W. Stiles, "The General Physiology of the Plant Cell and its Importance for Pure and Applied Botany"; Section L (Education): Mr. J. Sargent, "The Proper Function of Administration in Public Education"; Section M (Agriculture): Prof. R. G. Stapledon, "Lay Farming".

Section I (Physiology) will not hold separate meetings, owing to the unfortunate clash of date between the British Association and the International Physiological Congress at Zurich. It seems strange that no mechanism to prevent such collisions has ever been devised.

The sectional programmes, even at this early stage, promise at least as diverse interest as usual. By way of examples among many subjects: Section A will deal with nuclear physics, high-altitude cosmic ray work, very low temperatures, and seismology. Section B promises a notable

lecture-demonstration on gold films and their applications. Section C, among other subjects, will deal with the water supply of the county of London. Sections D and K will meet jointly to discuss the mechanism of evolution. Section G will consider problems of road and air transport, and will devote a special period to papers by junior workers. Section J will co-operate with Section D on questions of sense perception and the evolution of colour and pattern, and with Section L on the effect of the cinema and wireless on the life of the school child. Section L will discuss "Education for a Changing Society" in various aspects. Section M will consider agriculture in relation to national employment, soil conservation and enhancement of fertility, and crop and animal production.

The Conference of Delegates of Corresponding Societies will meet under the presidency of the Earl of Onslow, who in his address will discuss national parks, a subject to which the Association has properly given much attention. The evening discourses will be given by Dr. H. Godwin on the "History of the Fens", and by Prof. M. L. Oliphant on the "Contribution of the Electrical Engineer to Modern Physics". Of these, Dr. Godwin's discourse will be given on the Friday, thus appropriately preceding the Saturday excursions which will no doubt give many members a sight of the Fenland.

For the rest, full advantage will be taken of the exceptional opportunities offered by the various laboratories for exhibits and demonstrations, and certain special exhibits also are announced. Old scientific instruments will be shown under the auspices of the Cambridge Philosophical Society. There will be an exhibition illustrating the genetics of colour. It is proposed to have an exhibition of works of art by members of the Association—a feature, so far as records go, quite new to the programme. Members who would be willing to exhibit are asked to communicate with Mr. E. N. Willmer, St. John's College, Cambridge. Photographs taken by members of the recent scientific delegation in India will be shown. It is intended also that two lectures shall be given on the work of the delegation, of which it is hoped that one will be by Sir James Jeans, who led the delegation as president of the Indian Science Congress.

Provision for excursions is as ample as ever: the range extends from Sandringham on one hand to the Gliding Club at Dunstable and Tring Museum on the other, and opportunity will be afforded for visits to points of beauty and interest in Cambridge itself.

News and Views

Prof. Max Planck, For. Mem. R.S.

PROF. MAX PLANCK, originator of the quantum theory and emeritus professor of theoretical physics in the University of Berlin, will celebrate his eightieth birthday on April 23. Planck's work had a singularly direct influence on the development of modern physical theory. Beginning with purely thermodynamical studies—which have been embodied in his well-known text-book on thermodynamics—he soon applied both the descriptive and the statistical methods of thermodynamics to radiation, and was successful in finding a formula for the spectral energy distribution of black-body radiation which fitted the measurements and which could be deduced on the assumption that radiation is transferred from matter in quanta of energy proportional to the frequency ν. Successive editions of Planck's book "Wärmestrahlung" show the development and variation of the original theory, of which the underlying physical idea remained for many years a mystery to physicists, although Planck's constant h was found to enter into various relations between radiation and matter, for example, in the photo-effect. It was not until Bohr explained the laws of spectral emission of atoms by a two-fold application of Planck's constant that this latter was recognized as fundamental for all kinds of atomic action.

IN all this rapid development, Planck took a prominent, if cautious, part, with the result that his publications have long been considered as classics of German physical literature. His judgment largely influenced the development of contemporary physics. When Einstein's principle of relativity showed the way out of the axiomatic and other difficulties of electrodynamics, it was Planck who took up the idea and carried it through for mechanics and thermodynamics. Although many honours have been conferred on Planck, including the Nobel Prize in Physics in 1918 and the Copley Medal of the Royal Society in 1929, they have failed to spoil his simple and unpretentious ways. Confronted with the difficulties of the monetary inflation in Germany, Planck did not mind travelling a whole night on the railway in the old fourth class, in order to get to the Alps which he loved from his youth and in which a dolomite peak bears his name as the first to have climbed it. The German Physical Society is giving a banquet in the Harnackhaus on April 22 to celebrate Planck's birthday.

Sir Charles Peers, C.B.E., F.B.A.

THE gold medal of the Royal Society of Antiquaries of London has been awarded to Sir Charles R. Peers in recognition of his services to archæology in Great Britain. This medal, generally accepted as the highest award in archæology in Great Britain, has been awarded on three occasions only, the first recipient being Sir Arthur Evans, who was followed by the Abbé Breuil and then Sir Aurel Stein. Sir Charles Peers, who was educated at Charterhouse and King's College, Cambridge, and is by profession an architect, was appointed inspector of ancient monuments under the Board (now Office) of Works in 1910. His appointment was the result of prolonged agitation by archæologists and others interested in the preservation of antiquities in Great Britain. It marks an epoch in the history of British archæology. The inspectorship had been vacant since the death of General Pitt-Rivers in 1900, while the Ancient Monuments Acts, of which the first was passed in 1882, had long been virtually a dead letter. In 1913, three years after Sir Charles's appointment, a consolidating and amending Act was passed, which much enlarged the powers of the Commissioners, and he was given the standing and title of chief inspector of ancient monuments.

LARGELY through Sir Charles's activity, notwithstanding the interruption of the Great War, the growth of a public opinion in favour of the preservation of antiquities was fostered and the functions and duties of the Office of Works as the guardian of the nation's interests in its antiquities rendered familiar to a degree which made it possible still further to strengthen the powers of the Department, also recognized in the Town Planning Acts, by the further amending Ancient Monuments Act of 1930. Although Sir Charles retired in 1933, after receiving the honour of knighthood in 1931, he has since then still taken an active part in archæological administration. He continues to be a member of the Advisory Boards on Ancient Monuments of England, Wales, and Scotland, sits on the Royal Commission on Historical Monuments, as well as on the Standing Committee on Museums, and is an elected trustee of the British and the London Museums. In 1933 he was awarded the Royal Gold Medal of the Royal Institute of British Architects.

Dr. A. E. Dunstan

THE Council of the Institution of Petroleum Technologists has awarded the Redwood Medal of the Institution to Dr. A. E. Dunstan in recognition of his distinguished services to the science and technology of petroleum. The medal was presented on April 12. Dr. A. E. Dunstan was born at Sheffield in 1878. In 1899 he entered the Royal College of Science, South Kensington. Later on he studied at University College, London, under Ramsay and at East London College under Hewitt. At University College, Dr. Dunstan collaborated with Trouton on investigations into the correlation of physical properties and chemical constitution. He had already published work on viscosity-concentration curves of mixtures. This work was continued at University College and elsewhere, and formed the subject of his thesis in 1910 for the degree of D.Sc. In the meantime, he had communicated numerous papers to the Chemical Society on the problems of viscosity in collaboration with Thole, Wilson, Hunt, Stubbs and others. From 1905 until 1915 Dr. Dunstan was head of the Chemical Department, East Ham Technical College. In 1915 he joined the Anglo-Persian Oil Company. From that time dates the important series of researches on the chemistry and refining of petroleum with which Dr. Dunstan's name is particularly associated. The first important paper relating specifically to the petroleum industry was presented to the Institution in 1916 by Dunstan, Lomax and Thole, and dealt with the pyrogenesis of hydrocarbons. It described the evolution of the process of cracking and of the principles underlying it. A period of intensive research followed on the chemistry of refining processes, during which experimental work was carried out at Abadan and Sunbury. Dr. Dunstan is chief chemist of the Anglo-Iranian Oil Company and a director of National Oil Refineries, Ltd. He was president of the Institution of Petroleum Technologists in 1929–31 and has been honorary editor of the Institution's publications since 1920.

The Magnetic Storm of April 16

THE magnetic storm which occurred during the Easter week-end appears to have been one of the most violent ever recorded. Particulars of the disturbance have been supplied to NATURE from the Abinger magnetic station of the Royal Observatory, Greenwich, and from Edinburgh. The storm, as recorded at Abinger, considerably exceeded that of January 25 of this year both in range and in intensity. At intervals the photographic traces are difficult to follow on account of the rapidity of change in the earth's magnetic field. Beginning at 5 h. 48 m. U.T. with a sudden sweep of 45′ in declination, the storm almost immediately attained dimensions sufficient to place it among the "great" storms of the past hundred years. Only the salient features are at present available. These may be summarized as follows: The period of most intense activity was from 6 h. to 8 h. U.T. and the storm had virtually ceased by 16½ h. The whole range in the vertical component of the field was approximately 500 γ—not very remarkable except for the short interval of fifteen minutes during which it occurred—between 7 h. 35 m. and 7 h. 50 m. The ranges in declination and horizontal intensity are at present subject to reservation. On account of the rapidity of change some doubt exists as to the identification of the auxiliary traces which are brought into the record in lieu of the displaced ordinary trace when large ranges occur. A tentative estimate of 5° in declination and 2250 γ in horizontal intensity (that is, nearly one eighth of the whole) has been made by the assistant in charge of the Abinger station.

WRITING on April 19, Dr. A. H. R. Goldie, superintendent (Scotland) Meteorological Office, says: "The storm commenced at 5 h. 48 m. G.M.T. on April 16, and from the very disturbed traces of the magnetographs at the observatories of Lerwick and Eskdalemuir the following ranges in the magnetic elements on that day have been measured:

Lerwick Horizontal Force, 2980 γ (1 γ = 10^{-5} c.g.s. units).
Vertical Force, 1386 γ.
Declination, 5° 47′, equivalent to 1450 γ in the component of force perpendicular to the magnetic meridian.

Eskdalemuir Horizontal Force, 1672 γ.
Vertical Force, 1165γ.
Declination, 6° 25′, equivalent to 1850 γ in the component of force perpendicular to the magnetic meridian."

The storm was probably a sequel to the solar disturbance represented by the large sunspot group which crossed the sun's meridian on April 14·1 U.T. (see NATURE, April 16, p. 683).

Aurora Australis on January 22

A COMMUNICATION from the Commonwealth Solar Observatory, Canberra, published on p. 746, refers to an auroral display observed in Australia on January 22, and the solar eruptions and magnetic storms associated with it and with the brilliant display in Europe on January 25–26. Mr. John Gregory, writing from 11 Bennett Street, Perth, Western Australia, describes the aurora of January 22 as seen by him between 8.45 p.m. and 10 p.m. from Busselton, situated on the west coast of Western Australia, a few miles north of latitude 34° S. Throughout the display, short-wave reception from London was perfect and there was little interference in the broadcast from Perth. Referring to the suggestion that auroræ are sometimes accompanied by audible sounds, Mr. Gregory remarks: "I have witnessed many dazzling displays of Aurora Borealis on the Canadian prairies, in the stillness of remote farming areas, but was never able to detect sounds that could confidently be associated with the lights. The slight mysterious crackling sounds one might hear during a display could be heard on almost any cold night, even when the aurora was entirely quiescent."

Curious Effects of Globular Lightning

ON December 6 about 4.30 p.m., a ball of lightning was seen falling at an angle of about 30° to the horizon near Ardglass, Co. Down. It was accompanied by a glare and a loud noise, and on striking the ground there was a burst of flame from the point of impact, followed by a loud explosion. The spot where it fell was examined by Mr. J. A. S. Stendall, of the Belfast Municipal Museum, Miss M. Gaffikin, and Mr. F. Addey, who has kindly supplied all information collected from those who saw the phenomenon. The stem of a hawthorn tree ten inches in diameter had been cut through, and branches had been scattered around, one being thrown 100 yards away from the tree. The bank of a dry ditch had been struck, the point of impact showing clearly from the crushed soil, and fragments of clay were found forty yards away. Excavations were made, as it was believed at first that a meteorite had fallen, but no trace of such could be found at a depth of five feet. At the time of the appearance of the lightning a similar phenomenon was seen at a place six miles away in a north-north-west direction. People described this as accompanied by "a shattering blast which shook the whole countryside". A large crater was found in the mud of a river bank near the scene, but this was quickly covered by the tide and could not be seen when the spot was visited later. The portion covered by the impact could not have been localized to the area of the crater because one person, hearing the explosion, went out and saw sparks jumping off the macadam of the roadway. Mr. Addey suspected a meteorite which had disintegrated, as two balls of globular lightning, separated by six miles, occurring at the same instant, would be rather a rare phenomenon. The fact that a thunderstorm was in progress at the time near Belfast and Lisburn, combined with the fact that there was a partial failure of the electric light in the district, is almost conclusive evidence that the phenomenon was globular lightning.

Tring Museum

THE bequest of the zoological collections at Tring by the late Lord Rothschild is the largest single benefaction both in quantity of specimens and in scientific importance that the British Museum has ever received. The collection may be considered as in two parts, one open to the public and the other reserved for study. In the first section, a general zoological series, are many notable specimens such as the long series of giant tortoises or the superb set of Struthious birds, probably the finest in existence and containing many types. The gorillas and other primates are of equal importance and, in addition, there are specimens of rare or recently extinct animals such as the quagga and fine series of rare marsupials and monotremes. The condition of all these specimens and their taxidermy is of the best. The most important section of the study collections is undoubtedly the enormous series, some two millions, of Lepidoptera. The long series of individual species has yielded, and will continue to yield, much information of scientific value. These Lepidoptera include about six thousand type specimens, a fact which by itself would make this bequest one of outstanding importance to the British Museum. There is likewise an extensive library of zoological, entomological and botanical books comprising about thirty thousand volumes in all. Many of these books are of great rarity. This addition of the Tring Museum will lead, no doubt, to important extensions in the scope of systematic research. Hitherto systematists have too often been hampered by having to work with too short series of specimens. The late Lord Rothschild was alive to this weakness in the founda-

(*Continued on p. 743*)

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Social Relations of Science

"SCIENCE and its applications are not only transforming the physical and mental environment of men, but are adding greatly to the complexities of the social, economic and political relations among them". This passage from a resolution of the Council of the American Association for the Advancement of Science, published in NATURE of January 22, is representative of the widespread growth of interest, in recent times, in the social relations of science. The American Association has resolved to take as one of its objectives an examination of the profound effects of science upon society. This resolve seems to have been partly inspired by the movement, started several years ago, to make the British Association the platform in Great Britain for the discussion of social problems which science had helped to create and might help to solve.

Alongside these national movements, international action on the same subject has been taken by the International Council of Scientific Unions (I.C.S.U.). This important body, partly at the instance of the Academy of Sciences of Amsterdam, set up in 1937 a Committee on Science and its Social Relations (C.S.S.R.), as reported in NATURE of April 24 and May 22, 1937 (139, 689, 869). This Committee is charged to survey the influence of science on the world picture as well as on the material side of human life and society; it is to review science and its applications as a whole, and to promote the study of their social influence. Its initial plan is to prepare a report, with bibliographical material, to be presented at the next meeting of the I.C.S.U. in 1940, and thereafter, it is hoped, to be printed for wide circulation.

The collection of data on which the Committee on Science and its Social Relations will base this report is to be obtained from three sources: from national correspondents appointed by national academies or research councils, who will provide information on the national aspects of the social relations of science; from correspondents appointed by international bodies dealing with the several branches of science, who will report from the point of view of their particular sciences; and from individual correspondents having special interest in, or knowledge of, these matters. The appointed correspondents will in many cases find it desirable to enlist the aid of national or international groups of interested men of science, because the field of inquiry, especially for the national correspondents, is too wide to be covered by the knowledge of any single person. It is hoped that by this wide co-operation a report of great interest will be produced, though the difficulties to be faced in compiling it are obviously considerable.

To guide their correspondents in the collection and supply of information, the C.S.S.R. has drawn up a series of fairly detailed questionnaires, one for national correspondents, and others for the several branches of science on which the international scientific unions will report. It is hoped that the consideration and answering of these inquiries will play a useful part in stimulating and clarifying thought in scientific circles all over the world, on the social relations of science; and that the C.S.S.R. will receive from its many correspondents the support without which its efforts cannot but fall short of the great needs and opportunities before it.

The connexion of the C.S.S.R. with such important and established bodies as the International Council of Scientific Unions, the various international scientific unions themselves, and, still more, with the (in most cases) much older national

academies, gives it a representative position which could scarcely otherwise be obtained. These connexions in turn impose a duty on the Committee to make its work as scientific in spirit as possible, and in no way to compromise or misrepresent its parent bodies by partisan views or statements. In particular, the C.S.S.R. is not to be, or to be regarded as, a propagandist body; its functions are to survey, to study, to report.

It is excellent that the national academies and international scientific unions should take part in setting up and helping the work of such a body as the C.S.S.R., but the preparation of a condensed report of world-wide scope, to appear two years hence, and perhaps triennially thereafter, is far from sufficient to meet the need within each of the great nations, whose civilization is now largely based on science, for thought, discussion and publication on the social relations of science. Nor does it seem that in Great Britain the provision for such discussion, at the annual meetings of the British Association, is adequate. Further, national scientific academies, such as the Royal Society, probably do well to limit their discussions and publications to the natural sciences, without extending their functions into that great bordering region which the C.S.S.R. is charged to survey. Science itself has its controversies, sometimes keen despite the objectivity of the scientific method and spirit; in that border region beyond, though the like objectivity may be striven after, unity of opinion and agreement in discussion will certainly be more difficult to attain. It would seem best for both sides, therefore, that the arena for the discussion of the social relations of science should be separate from those in which the natural sciences are considered, though many representatives of each should be interested in both.

To be explicit, it has been suggested that in Great Britain (and the same applies to the other great nations) there should be a Society for the Study of the Social Relations of Science (S.R.S.), with a large individual membership, which should not be confined to men of science, though they should play the principal part in it. The Society should have its council, its regular meetings, its publications, and perhaps its committees for the study of selected questions. It should receive, read, discuss, and, after consideration by suitable referees, publish papers submitted to it; it might arrange symposia (by the spoken and written word) on special subjects within its range. Its field of work would inevitably trench on questions that have a political importance, but its attitude towards papers submitted to it should be scientific and objective, and it should not in general express corporate opinions, but leave readers to accept or reject the statements in its publications, according to their view of the credit of the authors.

This research method and policy of publication have proved their success in serving science in general, as in the case of the Royal Society, and the many branches of science now organized in separate societies, too numerous to mention; there seems good prospect that a like success would attend the same method and policy applied to this new field. The S.R.S. would be a society for the advancement of knowledge, not a propagandist body for the advancement of science in the public councils and esteem (like the former British Science Guild) or for the advancement of professional scientific interests (like the Association of Scientific Workers). Despite the existence of such useful bodies as Political and Economic Planning and the Engineers' Study Group, which are doing valuable work on the social relations of science, it does not seem that they perform the functions that are suggested for the S.R.S. Questions of overlapping and other difficulties may present themselves, but public scientific opinion on these matters now seems to have reached a stage where the formation of such a society is appropriate.

With the object of obtaining representative opinions upon the subject of social repercussions of science, and the question of promoting their deliberate study by the formation of a new scientific society or otherwise, advance proofs of the above article were sent to a number of scientific workers and others, with a letter inviting the frank expression of their views. The replies received are published in succeeding pages of this Supplement, and are grouped under headings representing in a general way the fields of scientific work in which the correspondents are particularly interested. It will be observed that doubts are expressed as to the need of establishing a new scientific society, and suggestions are made that the desired objects might be obtained through co-operation with existing bodies. Notwithstanding this difference of opinion, it is evidently the decided view of a number of responsible scientific workers that steps should be taken to further the objective study of social relations of science in the hope that the knowledge obtained may make both science and society conscious of their common interests and responsibilities.

Representative Opinions

Sir William Bragg, O.M., K.B.E., P.R.S.

If we assume the truth of the statement at the head of the editorial discussion of the social relations of science, we must conclude that the proposal to form a society for the study of those relations is entirely reasonable; and the statement is obviously true. The rapid and persistent growth of natural knowledge is something new in the history of the world. Its effects are very great, and there is, as yet, no organized attempt to correlate them. Attention is directed, now here, now there, to some remarkable consequence of the movement, sometimes with pride or gratitude, sometimes in fear. Both pride and fear are often mistaken. There is, in fact, much to be studied, and a society that sets about the task will probably arrive at results that will be interesting, and will be well worth the trouble taken to obtain them.

Sir F. Gowland Hopkins, O.M., F.R.S.

Science workers are often bidden just now to remember the complexities which science and its applications are adding to the world's problems, and to realize that it is their duty to help in shouldering the responsibilities involved. To-day, the situation must be considered no less from another point of view. Science itself is face to face with efforts, unfortunately only too successful, to impose on nations an artificial social structure of a kind which is definitely antagonistic to the progress of science, and in the long run, as history suggests, may even lead to its arrest.

I have often wondered, when laboratory workers, as such, are asked to take action, what precisely they can do beyond performing their duties as good citizens. It is clear that individuals can do little, and that experimental scientific workers immersed in research are ill qualified, when unaided, to take effective action of any kind. If solutions are to be found, the problems call for close study and careful analysis, and I venture to think that the effect of totalitarian policy upon scientific output should be continuously scrutinized and brought to notice.

It would seem that such tasks could be well undertaken by a society such as that proposed. It must, of course, establish international relations, and I think it would need the help of an information bureau. Its membership must certainly not be confined to the working men of science

Sociology and Economics

H. G. Wells

The essential difficulty in working out any special social functions for scientific men lies in the fact that, so far as the great majority of sciences go, the individual worker has no special aptitude for social organization. His time, his mental energy he owes to his special work. But this is less true of certain sciences than of others. It is less true, for example, of biology than of astronomy. It is less true of anthropology and psychology than of invertebrate anatomy. In the case of human ecology and social psychology, the man of science works in a field whose generalizations are almost immediately applicable to social organization. Every science insists upon integrity, explicitness and devotion to the extent of entire disinterestedness, and so the study and teaching of any science tends to brace the character and sweeten the social atmosphere. But it is through the pushing of the boundaries of science out into that field of rash generalizations and mischievous traditions known as human history, that the practical hope of mankind in science lies.

The S.R.S. claims the attention and frank criticism of every type of scientific mind, but if it is to operate efficiently it will have to create opportunities and support for an increasing number of social biologists and social psychologists. There is little advantage to be found in the distinguished experimentalist in physical science dissipating his time and genius in amateurish contributions to political and social theory. There is everything to be gained by a S.R.S. that will keep him in touch and co-operation with social scientific work and thought as intensive as his own.

Prof. John L. Myres, O.B.E., F.B.A.

Is the proposed Society for the Study of the Social Relations of Science to be yet another 'learned' society, or something else?

In the natural sciences, physical and biological alike, there is no limit to the applicability of discoveries to human ends, economic and social, "transforming the physical and mental environment of men". Such applications are the concern primarily of individuals competent to supply admitted needs of their fellows, and eager to stimulate fresh needs; next, of specific associations for the promotion of such enterprises, in medicine, engineering, various industries, and the like; and ultimately of the citizens at large, and their organs of administration and policy, competent to use, abuse, or disuse. Philosopher-kings and totalitarian dictators presumably provide for inclusive survey of all applied science 'in the interest of the governed'. Like the centurion, they "say unto this man 'go' and he goeth"; unlike him they are not "under authority" and nothing printed in Nature need affect their doings. In a 'free' country, what form does "King Solomon's House" assume?

Clearly 'social relations' are not the business of the 'learned' societies. The less these are concerned with 'practical applications' or with practical restrictions, the better. For all these involve judgments of values—considerations political or moral, not scientific at all.

I have the same uneasiness about 'applied anthropology' as about 'applied' genetics, when undertaken by a 'learned' society; for 'learning' and life are fundamentally different. From the dentist to the destroyer, we all 'apply' gas. Some also 'apply' prayer, to avert pain and war. But these 'applications' concern neither chemists nor theologians.

Though the Committee on Science and its Social Relations is "charged" by the International Council of Scientific Unions, one of the greatest of 'learned' societies, and is, as stated, "not to be, or to be regarded as, a propagandist body", it is nevertheless expected to "play a useful part in stimulating and clarifying thought"; there are "great needs and opportunities before it"; and it is concerned (among other matters) with the "national aspects" of the social relations of science, which differ notoriously between one nation and another. But this is politics, not science.

The British Association, in addition to the "promotion of scientific enquiry" and of "intercourse between those who cultivate science", has among its objects "the removal of any disadvantages of a public kind which might impede its progress", and has often attempted this, and still oftener been urged to attempt it. But these functions are concurrent and distinct.

So too these current inquiries of the American Association are concerned with the "complexities of the social, economic, and political relations" among men, and are distinct from its function of discovery.

Is the proposed Society for the Study of the Social Relations of Science designed to be yet another 'learned' society, duplicating or supplementing the activities of the C.S.S.R. and the American Association? It "would be a society for the advancement of knowledge, not a propagandist body" like the British Science Guild or the Association of Scientific Workers. But also "it would inevitably trench on questions that have a political interest and importance", like the British and the American Associations. Its promoters should make up their minds whether it is to be a historical, or a philanthropic society; a society for the Study of Spilt Milk, or for Promoting the Good Will among the Stronger.

Prof. H. J. Fleure, F.R.S.

THE development of machinery has made productive capacity enormous and thus accentuated rivalries, while the increase of modern communications has made national frontiers a source of increased irritation, and the jostling of peoples has inspired fear for the future of cherished national traditions. Sources of machine-power, again, have changed, and some who look into the future are inclined to picture a world largely dependent on power-alcohol from cellulose, which means that relations of Europe to the warm lands will enter a new and difficult phase.

In other directions also, science is having far-reaching effects on thought. The idea of evolution working itself out in comparative religion and in psychology is beginning to have revolutionary influences on ethics and beliefs, effects as yet only dimly perceived by many leaders of religious organizations. Again, the accumulation of knowledge concerning ancient and modern China, India, Mesopotamia, Iran, Egypt, and so on, is altering into a sort of glorified provincialism the old habit of starting an argument concerning society with examples from classical Greece and leading on through Roman, medieval, renaissance and later periods. We are in the throes of as deep a change of both economy and thought as that which included the breakdown of the medieval church in north-western Europe and the voyages of discovery. Old bases of conduct, sources of social motive power, visions of the world, are changing, and there is a natural recrudescence of authoritarian ideas as a fear-insurance against chaos, or against the triumph of an equally authoritarian rival.

The change is in the main the effect of the impact of science, of the vision of truth as something to be sought, of the consequent view that all beliefs are provisional and that neither reason nor emotion gives us final conclusions. It therefore seems that scientific workers owe it to the community to see that they study the social relations of science. A recent election of a student of physiology as a professor of philosophy is a welcome indication of awareness of the change in thought that is beginning. If necessary, we must found a new society to study these matters, however difficult it may be to ensure reasonably unprejudiced discussion.

Might we not, however, try to encourage existing societies that study mankind in the broadest way to occupy the field? Anthropological and folk-lore societies, in co-operation with sociologists, historians and geographers, should realize increasingly that our own social life is material for study just as much as is that of distant peoples of the present and past. The influence of science on production, transport, population and its distribution, social motive power, and the springs of conduct and belief can all be considered as within the anthropological field, wherein have long worked many who know a great deal about lowly peoples and ancient society, and so can help us to know the rock whence we were hewn and the manner of the hewing. A conference of workers interested in the problem of the social relations of science is clearly called for, together with a consideration of the difficulties arising in our universities from the old division into faculties of arts and of science, which is becoming a hindrance and was never more than a practical convenience.

Prof. P. Sargant Florence

IT is often said that economists are blind to the impact of science upon society and that they are neglecting the changes that have come over industrial organization as a result of scientific invention. This may be true of the school of economists who argue from traditional assumptions carried over from an age when science *was* negligible. But it is impossible for any realistic economist trying to generalize from actual events to ignore the consequences of scientific progress. In my presidential address to Section F of

the British Association last year, for example, I directed attention to the increase in the number of men per factory and to typical differences in the number of men per factory as between different industries. This general increase and this differentiation both appear to be correlated with technical factors, particularly the growth of mechanization. Mechanization measured by horse-power and overhead costs per man has increased generally, and in those industries where mechanization is greatest the number per factory tend to be greatest. The higher the mechanization of an industry, the larger is the size of its constituent parts.

Scientific invention has led to more machinery being installed. More machinery has led to more men being employed in one organization. In its turn this large grouping of men is leading to the invention of new sorts of social organization. More capital is needed to buy the machines; joint stock companies are formed to pool capital. The control of larger and larger groupings of machines, men and capital becomes increasingly difficult for the joint-stock shareholders, and the power over each company is put into the hands of boards of directors usually representing a minority of investors. The companies themselves become too small as units of control, and methods of concentrating control are devised such as interlocking directorates and holding companies.

By the time this stage has been reached, economic organization has become the concern of society as a whole. Consumers are faced with the possibility of monopolistic exploitation. Citizens are faced with dictatorship by high finance. In this pass, to study the social relations of science is the least society can do! The impact of science, though working indirectly through the economic mechanism, may well be overwhelming in its ultimate effect. Certainly we must be prepared, by the formation of such a society as the proposed S.R.S., to measure the force and direction of the impact. And I venture to think that the economic mechanism, such as I have outlined, through which science affects society, must be investigated particularly closely. For this a certain professional training in economics and the social sciences seems to me essential—a student of natural science cannot leap at it by the mere light of Nature! May I suggest, therefore, that an early task of the proposed S.R.S. be to find means for professional training in realistic methods of economic and social research?

Prof. H. A. Marquand

I AM enthusiastically in favour of the establishment of a Society for the Study of the Social Relations of Science. Students of social problems are often, like myself, childishly ignorant of the natural sciences. On the other hand, I have often heard very competent men of science utter childish opinions about social and economic questions of the day.

The need for co-operation and closer contact between the two branches of study has been admirably expounded in NATURE. I would only add that if the new society is formed, it should confine itself to persons fully qualified in the fields of study it hopes to unite. An immense amount of valuable time will be wasted if the numerous quacks, well-intentioned but untrained, who pose as authorities on economic and sociological questions are admitted.

The task before the new society is urgent; and it should not allow itself to be diverted from profitable lines of research by a sentimental desire to be 'fair' to all 'points of view'. Economists, in particular, will be quite prepared to recognize the authority of a duly appointed university teacher or fully qualified research worker in his own field of science. Let the men of science seek the co-operation—at least at first—only of persons similarly qualified in economics. It will be found that there is a large amount of agreement among them on fundamentals of analysis.

At a later stage, the findings of the society can be presented with real authority to the public. The public itself can then make its choice between the alternatives available—for there always will be alternatives in social policy. What the society can do is to ensure that the alternatives are thoroughly understood and that as many as possible of the data required to ensue the choice are scientifically prepared by fully competent persons.

Prof. Harold J. Laski

I THINK the idea of such a society as is suggested may prove of real value; few things are more important at the present time than the interchange of views between men of science and those who are concerned with the study of social phenomena. Their past separation has been a grave misfortune since (*a*) it has led to the neglect by scientific workers of the several implications of their own work, and (*b*) an inadequate knowledge by statesmen and by professional students of several organizations of the implications of scientific discovery. A body that might help in breaking down the existing barriers is, at least potentially, one that has important work to do.

It is, however, important, I think, to emphasize that such a society must occupy itself as well with ends and values as with the description of phenomena. Work like that of Sir John Orr has implications which go out into the realm of action; it emphasizes the need for scientific workers to give, as it were, the laboratory to life. The man of science is also a citizen. He has the responsibility of seeing that the conclusions he reaches are related to the purposes our social order is seeking to fulfil.

Prof. Morris Ginsberg

I SYMPATHIZE very strongly with the proposal to establish a society for the study of the social relations of science. I should, however, like to make a comment from the point of view of sociology. It is, it seems to me, very important that society itself should be studied scientifically, if the effects upon it of the achievements of the natural sciences are to be correctly interpreted. On one hand, science is itself a social product, and its evolution is shaped at least

in part by social and economic forces, and these are matters for sociological inquiry. On the other hand —and this is in relation to the present proposal more important—the study of the effects of science on social relations requires not only a knowledge of science, but also of social relations.

Now, though in fundamentals the methods of science are the same whatever may be the field of inquiry, it is not be be assumed that the technique of the natural sciences can be applied forthwith to the field of social relations. The history of social thought offers abundant illustration, of which the most striking, perhaps, is the hypothesis of natural selection, of the disastrous consequences that have resulted from the application of scientific theories to social problems without direct examination of the sociological data.

If, therefore, as I hope, the society is established, I think that one of its functions should be to encourage the direct study of social facts, and that on its councils sociology should be adequately represented.

Alexander Farquharson

THE proposal for the development of new means for the study and discussion of the social relations of science will have, I am assured, widespread support among sociologists. To these, the subject is not new. Much thought has already been given to the social origins of science and to its social effects. It is, however, undeniable that a systematic and co-operative effort to examine these and similar problems would have fruitful results. In such an effort, students of both natural science and of sociology should take a full share. I hope that some historians of culture and some philosophers with a social outlook may also be ready to take part. It may, however, be suggested that use should be made both of the observational method of the scientific worker and the methods used by the historian and the social student in the study, through documentary evidence of past and present.

Psychology

Prof. C. Spearman, F.R.S.

AMONG the sciences at issue an important place can scarcely be denied to that of the mind. Indeed, seeing that this is a field which covers all knowing, feeling and doing, a plausible case might be made out for crediting this mental science with ruling everything in the world that possesses value as an end, and not merely—like the material sciences—as a means. In special degree, surely, this holds with regard to social values. In good enough accord with this *a priori* staked-out claim of psychology, we find in actual fact a more universal appeal to it for aid.

First of all the appellants came education. Not far behind was mental pathology. Later, but trying hard to make up for lost time, have been the calls to assist industry. Still more modern is the acute realization of the psychological basis of criminology. Last of all, perhaps, has been a lively call to solve the problems of polemology (*sit venia verbo*).

On the other hand, however, there are not a few sceptics who would make out that the promises of psychology are greater than its performances. Unfortunately, this charge does appear to have not a little foundation. Nevertheless, it can certainly be exaggerated. In many cases the social achievements of mental science stand out far beyond the reach of all legitimate cavil. Take, for example, the new developments of knowledge about individual mental differences. At the most conservative estimate, this knowledge would appear to be fundamental for all social organization and endeavour; from, say, confiding in M.P.s to sterilizing the unfit.

Here we arrive at one last critical point. Let us grant that mental, at least as much as material, science has vital relations to society. We have still to inquire why these relations should be thought to need special treatment, by committees, associations, and so forth. May not rather the relations be taken as already treated in an adequate manner by the two studies thus related, psychology and sociology?

The answer would seem to be decidedly in the negative. Here, as in so many other branches of science, the application of one to another is apt to be a very delicate and difficult operation. A notorious illustration is furnished by the frequent complaint of physiologists, that they urgently need the aid of chemistry, but not such as is currently supplied by chemists. In their turn, psychologists stand in a very similar relation to physiologists. So likewise, it would seem, do sociologists to psychologists.

By all manner of means, then, let us get together. The whole situation, after all, is but an instance of the old saying that sciences grow where they meet. Accordingly the advent of the S.R.S. would seem to deserve a cordial welcome.

Prof. J. C. Flugel

THERE can, I think, be little doubt that a society such as is contemplated could perform a very useful function, a function indeed which, before long, we may come to look upon as indispensable. I imagine, however, that to fulfil this function properly the membership will have to be drawn in about equal proportions from scientific workers proper and from men engaged in the practical tasks of organization and administration in the most diverse spheres, not excluding that of politics.

As regards its individual members, the society will have a double task. On one hand it will foster the increasing sense of responsibility which scientific workers are beginning to feel for the social consequences of their discoveries: while in the executants it should cultivate a corresponding ideal for the full and proper use of science and—what is even more important—for the adoption of a scientific attitude in those fields, for example, of politics and economics, where traditional or emotional bias is only too apt to interfere with a calm and impartial investigation of relevant facts.

Society to-day is based on science, and it is becoming recognized that the social problems created by science can only be solved by yet further

extensions and applications of scientific method. Those who make scientific discoveries and those who apply—or misapply—them should be looked upon as members of a team with a joint responsibility to the human race at large. The better the understanding between them and the closer their co-operation, the better it will be for them and for society. The man of affairs can suggest innumerable problems to the man of science, many of which can be dealt with by well-known existing scientific methods, while others will probably stimulate research in new and profitable directions. The man of science, on his part, will be helped to realize how much of human life is still muddled and unscientific, still awaiting the illumination which only science can bring. The co-operation of the two types of men in a single powerful body may eventually help to bring about a vast extension of the scientific field—with, of course, a corresponding increase in the number and influence of scientific workers themselves.

The society, I take it, will be no mere paper-reading association, though the interchange of views at meetings will be an essential task. It will also, as I envisage it, become, at least eventually, a consultative body to which politicians, social administrators and industrialists will naturally turn for help and information, and to which men of science also will apply for assistance in obtaining such social facilities as they may need for their work (and in the case of the human sciences such facilities may be of great importance).

As the work of the society proceeds, the establishment of special advisory committees—temporary or permanent—will probably be necessary, and in this connexion the society will possibly co-operate with, or incorporate, certain smaller and more specialist bodies already in existence. The main function of the society will, I take it, not be propagandist: nevertheless, it might undertake a certain amount of directly educational work in certain fields where a wider popular appreciation of scientific findings appears to be particularly urgent.

In founding the society, care will have to be taken not to define its constitution or functions with too rigid a precision: so that full advantage may be taken of that most precious characteristic of British institutions—their ability to evolve as circumstance or necessity requires.

Dr. Charles S. Myers, C.B.E., F.R.S.

In these days no one will welcome the formation of a new society unless it can be shown to serve a new and important purpose. But a Society for the Study of the Social Relations of Science does seem to meet a new need. If its council include representatives of the chief existing societies which are already concerned essentially with social affairs (for example, those bodies dealing with public health, applied psychology, ethnology, sociology, etc.), the S.R.S. will constitute a new body which will for the first time bring together in mutual sympathy and co-operation all interested in the various social implications of such 'human' sciences. But by the present proposal its sphere will be enormously widened, and become correspondingly more valuable by the inclusion of the 'purer' sciences of physics, chemistry, and biology, together with their applied aspects of engineering, pharmacology, etc.

This new society will not only encourage in research workers a fuller recognition of the actual and possible social implications of their work. Its activities will also impress on the general public the important social bearings of the physical and biological (including the 'human') branches of natural science, and will increase the national support of scientific research. I hope, therefore, that the S.R.S. will come into being, and I believe that it will serve a valuable scientific and social purpose.

Prof. F. C. Bartlett, F.R.S.

I should like wholeheartedly to support the proposal for the formation of a Society for the Study of the Social Relations of Science. Everybody now agrees that the impact of almost all branches of science upon social life is intense, and that the problems which arise as a result of this impact have a significance for the future of civilization, both national and international, which can scarcely be exaggerated. Most thinking people are coming to realize also that these problems are as amenable as any others to scientific study and direction.

There is at present no adequately constituted body which can co-ordinate the many sectional and specialized interests which are being attracted to a study of the social implications of particular branches of science; but without such co-ordination development is bound to be not only tardy, but also ill-balanced. I also agree completely with the view that the primary need at present is for the formation of a number of properly constituted national scientific groups for the study of the social relationships of science. The problems involved are so complex, so influenced by the established culture of differently organized national groups, that an international body alone cannot hope to cope with them, in the first instance with much promise of success.

I believe that the time is fully ripe, in Great Britain, for the establishment of a society with the constitution and aims described, and that such a body would perform a service of value for the nation, and ultimately for mankind.

Biology

Prof. A. V. Hill, O.B.E., F.R.S.

A notable example of the need to study the social relations of science is in the matter of public health. If guided scientifically, the present general interest in 'national fitness' may be the beginning of an altogether new outlook on human biology, destined to place the maintenance of health and the development of normal human faculties, as equal partners with medicine, in the place reserved at present for the treatment of disease. The scientific knowledge

is already largely available: the social applications of it require public action which scientific workers alone cannot take, but in which they must be the guides of public opinion if the action taken is to be wise and effective. This is an international as much as a national problem, and one in which all kinds of co-operation, political, economic, moral, as well as scientific, are needed.

The obligations of scientific people in the matter of national defence will doubtless be referred to by others. Warfare, unfortunately, is not out of date, and it is certain that in the present state of the world its methods will be largely based on science. A free country in which the best scientific men were unwilling—from whatever motives—to co-operate in defence, would suffer from the grave disadvantage of having to employ the second best. Science in the free countries must be willing to play its part, or they may cease to be free: and—apart from anything else—if no freedom be left science will be deprived of its chief instrument, frank and open criticism. Already in countries which are not free it is difficult (at least for the non-expert) to discern what is truth and what is propaganda.

One of the problems certainly of the proposed society would be that of the use—or misuse—of scientific research and knowledge for purposes of war: but this problem is only part of a much larger one, that of the use of the common property of scientific knowledge for selfish purposes. The ethics of secrecy in research, of patenting discoveries of value to the public, of advertisement, of 'expert evidence', of permitting scientific quackery, of exploiting dangerous knowledge or selling dangerous drugs—all such matters are parts of the same problem, not always easy to solve: as indeed is that of using a reputation gained by scientific work, or reflected from the main body of scientific workers, for any sectional or selfish purpose. Medicine for thousands of years has had its standards of ethical behaviour, sometimes abused no doubt, but on the whole an enormous safeguard to the public and to medical men alike. Science needs similar acceptable standards, and one of the chief functions of the new society might be to consider the general question of scientific ethics.

Prof. John S. B. Stopford, F.R.S.

The effects of the applications of science upon social relations are evident to all, and few will dispute the urgent need for the dispassionate study of the perplexing problems which have arisen. The present facilities for discussion of these problems and the provision for publication are clearly inadequate, and it would be disastrous to charge the national scientific academies with this work, although scientific workers cannot divest themselves, as individuals and citizens, of a responsibility. It would appear inevitable that the task can only be undertaken by such a new society as the one suggested.

The great difficulties appear to arise at that point, and some of the more important safeguards are stated in the preliminary editorial. The matter which the society will have to survey, study and report upon, is of such a nature that it will not always be easy to avoid propaganda and bias, and yet its success will depend to a large extent upon the most strict avoidance of even a suspicion of the intrusion of such things.

One doubt in my mind is whether a Society for the Study of the Social Relations of Science can not only adopt, but also maintain, the method and policy which has proved so successful in the case of the various scientific societies. The new field to be studied is so different that this question seems initially to be the vital one. Another doubt concerns the composition of the contemplated society. It seems doubtful whether men of science ought to take quite such a principal part as is suggested. The consequences of science are so varied and of such a kind that it is most important that the society should have the full benefit of the advice of many others competent to bring knowledge which does not fall within the experience of the scientific worker.

These and others are matters which of necessity will demand much thought, but I earnestly hope that serious consideration will be given to the proposal for the formation of a Society for the Study of the Social Relations of Science.

Prof. J. B. S. Haldane, F.R.S.

It is obviously desirable that the social relations of science should be studied. But it is equally clear that such a study presents formidable difficulties, and I question whether, even though it does not express corporate opinions, the attitude of the proposed S.R.S. towards papers submitted to it will always succeed in being scientific and objective.

The choice of papers is to depend on "suitable referees". I do not envy them their task. They will have to avoid, on one hand partisanship, and on the other the temptation of rejecting communications voicing 'extreme' opinions merely because such opinions will be offensive to some readers or hearers.

I trust that one condition will be rigidly enforced. Membership should be individual, and no scientific society should be asked to nominate delegates. For example, the Genetical Society includes on its council members with very various opinions concerning eugenics and racial purity. If it were asked to nominate a delegate to the S.R.S., it would be inevitable that these opinions, as well as scientific achievement, would be considered in elections to its council, and a formidable blow would be struck at the society's scientific integrity.

But if this and other safeguards are carefully, and even pedantically, enforced, the S.R.S. may play a valuable part in bringing to light the relations between science and other social activities. I trust that the word "science" will not be too narrowly interpreted, and that anthropologists will be encouraged to discuss the development of technique in primitive societies and its impact on social structure and function. Only against such a background are we likely to view contemporary problems with any approach to objectivity. For the same reason, it is vital that the society should include members

not merely engaged in the directive side of industry, but also in manual work. For it is clear that one of the main social consequences of scientific progress has been to alter the functions and status of manual workers.

If these and other conditions making for objectivity are fulfilled, I believe that the S.R.S. can perform a most valuable function. But if not, it may easily become a propagandist body, either for some particular theory, or more probably for the preservation, with trifling modifications, of our existing social system.

Sir Peter Chalmers Mitchell, C.B.E., F.R.S.

My difficulty about the proposed new society is that the social relations of science cannot be studied in a scientific vacuum, but must be in an atmosphere daily becoming more inflamed by the opposition between the two views of society which, using the terms in the broadest sense, may be called the capitalistic and the socialistic. For example, the sudden discovery of a large-scale method of synthesizing starch or sugar might, and probably would, produce a panic in a capitalistic State, and be a welcome boon in a Marxian organization. But the new society certainly would be interesting, and would be rocked with dissension in exact proportion to the intellectual integrity of its members.

Prof. W. E. Le Gros Clark, F.R.S.

New developments in the history of science are only rarely due to the discovery of facts hitherto unknown or to the elucidation of new principles—more often they are the result of a conscious realization, sometimes quite abrupt, of relations and perspectives which have previously been unconsciously accepted or only dimly recognized in the background. But the general background must ultimately be taken into account in judging the implications of any line of scientific development, even though attention tends at first to be concentrated on the separate and more conspicuous details which are the immediate interest of the laboratory worker.

The social background has always been present in the history of science, playing an important part in directing the inquiries of the man of science along specific lines, and being itself also influenced by the results of his discoveries. It is possible now to look back and see quite clearly these interactions, of which the scientific workers of the time were themselves completely unaware. The conscious realization of the social relations of science, indeed, has only recently been generally acquired.

This has more than a theoretical interest, for it marks the first step towards their ultimate control. Herein many see an inspiration for the future. It is one of the achievements of modern psychiatry to have demonstrated that a mental attitude can only be adequately controlled when the individual becomes fully conscious of all the factors by which it is determined. This thesis is equally applicable to external situations. Consequently, having become aware that the social relations of science are really potent as an influence both on the development of science itself, and also on social evolution, it is now urgently necessary to develop as completely as possible our conscious appreciation of the processes underlying this reciprocal action.

This can only be achieved by an extensive analysis of the effects of the progress of scientific discovery on human society, and of social developments on scientific progress, in the past and present, with the object of determining precisely how these effects are brought about. The results of such an inquiry must be formulated with complete objectivity in order to provide a truly scientific foundation for the adequate control of the same processes in the future. That such control is, to say the least, highly desirable, will become more and more apparent as the inquiry proceeds.

Those exponents of social systems who are most eager to belittle the claims of science for representation in directing the destiny of mankind are precisely those who are making the fullest use of the achievements of the scientific worker in the pursuance of their own interests. The misapplication of scientific discovery in the promotion of social evils, no less than its justifiable employment for the true benefit of humanity, requires to be clearly and objectively expressed, as a necessary preliminary to securing proper recognition of the status of science in the social order. The proposal for the institution of a Society for the Study of the Social Relations of Science could scarcely come at a more appropriate moment, for such a society would provide the obvious mechanism for initiating the first step by scientific workers as a body in an attempt to carry out this ideal.

Prof. J. Graham Kerr, M.P., F.R.S.

I am naturally much interested in the proposal to found in Great Britain a Society for the Study of the Social Relations of Science. The special relation to which I have endeavoured on many occasions during the last twenty years to direct attention is the application of science to the training of the citizen. The system of education as we know it to-day is the system that has come down to us from medieval times. Designed in those days for the training of the priesthood, and extending secondarily to the upper classes of the community, it was this system of training—in the main literary and cultural—that naturally became the system of education for the ordinary citizen, as the development of the art of printing made possible its diffusion through the community. Modern developments in education have been, in the main, improvements in technique, which have left its general framework untouched.

I had the advantage in my early days of acquiring intimate personal knowledge of a comparatively primitive race of men still in the nomadic hunting phases of communal evolution, and it was of extraordinary interest to compare their system of education with that of our Western civilization. With them the end aimed at and reached was fitness—bodily, mental and moral—to play their proper part as members of the community. Hard exercise and plain, sparse diet developed a hard, lean body of A1 quality. Games

simulating war and the chase developed the senses to the highest pitch of acuity, and the mind to draw rapidly and correctly the proper conclusions from what was observed. Instruction by the grown-up members of the tribe instilled into the youthful mind the hard code of tribal ethics and discipline, infringement of which brought severe punishment.

What will, to my mind, be one of the most urgent tasks before the S.R.S. will be to tackle the problem of how we are to get the training of our citizens back to a system in which mere superficial culture is brought into proper proportion with, on one hand, such branches of intellectual training as skill in observation and in the thinking out of the correct conclusions, and, on the other hand, the development of physical fitness and moral discipline.

In this strange new world which has evolved during the past century or so—a world in which ideas, good or evil, are swiftly diffused through the community by printing, wireless, the cinema; in which security from pestilence is dependent entirely upon the advances of medical science; in which the very food supply depends upon the applications of science—in this strange new world the call is urgent for such an investigation of the social relations of science as is suggested, if indeed our civilization is to be saved.

Prof. J. A. Ryle

THE medical sciences, above all others, should keep continually in view their responsibilities in connexion with the maintenance of social relationships. Never before has the ground been so abundantly prepared for fruitful contributions on their part to social reorganization and human betterment. The 'time-lag' between discovery and application is often disturbing. This and the modern acceleration of discovery have made it necessary to envisage more effective measures for ensuring free intercourse between the scientific workers and the legislative councils of a country. A Society for the Study of the Social Relations of Science could clearly give valuable help in this direction.

In the preventive field of medicine particularly, requisite data for new and effective reforms are constantly coming to hand. In the matter of control of infection in its epidemic forms, most civilized States are already well advised. There remain, however, other sources of serious infection in the community, as in the case of the milk-borne diseases, which are now known to include the typhoid fevers, brucella abortus infections, and certain grave streptococcal diseases. For the mode of origin and transference of these, science has provided the evidence, and for their prevention the necessary instructions. With healthier and tested herds and compulsory pasteurization and bottling of milk a vast amount of sick-wastage and many hundreds of lives could be saved in Great Britain every year by means of legislation which should not present grave difficulties or inflict any commensurate hardship or alternative risks.

Much could be done to further the recognition and control of droplet infections. In institutions such as schools, hospitals, barracks and offices, these are responsible for a large and continuous sick-wastage and a high incidence of serious diseases, including scarlet fever, pneumonia, meningitis, septicæmia and otitis media. Spacing of beds, better ventilation and measures permitting earlier segregation of infected persons might call for heavy initial expenditure, but the eventual saving of time and labour, health and life, would make ample repayments.

Recent nutritional research has shown that, apart altogether from rickets (now becoming rare in its florid form in civilized States) and scurvy, beriberi, and pellagra (which are largely confined to poverty-stricken zones and native populations), there is in every country much widespread chronic ill-health and inefficiency directly attributable to subnormal diets. The growth and health of children in poor industrial areas and in the homes of many agricultural labourers are still seriously handicapped by protein and vitamin deficiencies, and under the same conditions young mothers frequently suffer from serious mineral deficiencies, especially in respect of iron. The evidence for this has been fully substantiated by social and dietary surveys on one hand, and by clinical and nutritional research on the other.

That such conditions should exist in a wealthy country suggests not only that the organization of society itself must become an even more urgent concern of the sociologists and politicians, but also that there are at present too many obstacles to the transmission of knowledge from the scientific workers to the legislature and to the community at large. In the genetic field knowledge has sufficiently advanced (given the assistance of better education both for the doctors and the public) to make practical measures both of positive and negative eugenics feasible, and this without any interference with the rights and liberties of the individual.

In brief, a more concerted attack upon all the diseases and disabilities, with their attendant loss of time and labour, which are attributable to endemic infections, malnutrition, inadequate light, air and exercise, and uncontrolled and uninstructed breeding, is overdue, and there can be no contradiction of the scientific evidence which declares it to be so.

Any organization which may assist the study of the social relations of the biological sciences and encourage the better application of new knowledge will be likely to receive the warm support of medical men in whatever branch of practice, education or research their work may lie.

Prof. F. A. E. Crew

NOTHING is more desirable—even necessary—in my opinion, than that some organization, with the structure and the functions of the suggested S.R.S., should at once be brought into being. Nothing could be more urgent, more opportune. But, for a number of reasons, I should like to see it grow into a section of the British Association, which I sometimes think now requires a fresh purpose.

It is generally accepted that the world we live in has been re-shaped by science; that our social structure is utterly dependent upon the creations

that science has made possible; that there is no longer any question of a return to the domination of Nature; and that man must strive for the complete mastery over his environment, and must secure the power to control his own further evolution.

Scientific workers are enrolled in great numbers in the service of the community, for the reason that those who are in charge of our social evolution are persuaded that only through the further and more intensive application of science to human affairs can we hope to solve the many and complex problems of society. Those who work at the forge of some specialism in science are commonly aware of the possibilities concerning the use of the tools that they are fashioning, and are distressed when these are used not at all or else are employed unintelligently for unworthy purposes. While it is not to be expected that they themselves should be able to construct sound policies relating to human and social betterment, since in them thought is inclined to run in narrow grooves, and the treatment of the rest of life's interests tends to be somewhat superficial, yet from them and from them alone can come certain kinds of information of the greatest possible value, strong threads of ascertained knowledge which can be woven into the social fabric by such as there may be whose minds do not lack balance.

On the other hand, there is an educated public, keenly and anxiously aware of the quality and the promise of the contributions that science is making, eager for further information and understanding, and seriously interested in matters of government. The suggested S.R.S. could provide a meeting place for those men of science who gladly accept the view that science is an instrument which society is using for its own purposes, and for those who are interested in, or concerned with, statecraft, acknowledging that it is to science that we must look for any lasting contribution to the permanent advancement of man's well-being.

The hope of the future, I think, lies in the fact that the biological sciences have grown so large and needs must grow larger. In them is to be encountered knowledge that, intelligently used, will certainly remodel mankind and re-fashion society. But for the present these are largely neglected, for science is now encouraged mainly for economic reasons, and its fruits are used almost exclusively for economic ends. The S.R.S. would be serving a most useful purpose if it could act as an amplifier for the voice of the humanist, for nowadays this is drowned in the ceaseless noises of calculating men and machines.

Prof. E. J. Salisbury, F.R.S.

ANY addition to the numerous societies that already exist would need ample justification; nevertheless it cannot be doubted that the contacts which scientific advance makes with the broader aspects of human affairs are often entirely neglected, despite their manifest importance. For example, though the social study of plants is by no means a new one, the importance of our knowledge of plant communities in relation to such matters as erosion and water supply is only just beginning to be recognized. The findings of the ecologist and plant physiologist have their significance for the student of amenities no less than for those concerned with the conservation of a shore-line or the maintenance of a national park. The dynamic character of communities of plants and animals, the changing nature of their balance of life, have important practical implications which are not only neglected but also often unrealized.

Here, indeed, as elsewhere, the gathering momentum of increasing specialization has its grave dangers unless accompanied by a correspondingly augmented synthesis of knowledge. The fostering of a balanced mental nutrition is perhaps the most important function which the universities should to-day perform, for they almost alone are the guardians of this synthesis of thought between one and another branch of pure knowledge. But there is no continually functioning body the special concern of which is to develop and maintain the cross-currents of knowledge in all their wider applications to human affairs. It may be justifiably asked whether there is not a real need for some body the main function of which would be to focus attention on the social implications of advances in science and, whilst meticulously avoiding any propagandist or political bias, would educate public opinion in these respects.

Dr. J. S. Huxley, F.R.S.

I AM sure that the establishment of a Society for the Study of the Social Relations of Science would be of great value. At the moment, there is no common meeting ground for those interested in such problems, and the result is a scattering of aim and a lack of agreement as to method. As a matter of detail, it may be suggested that the meetings of such a society should not always be held in the same spot, but at different places, and perhaps often in conjunction with the meetings of other societies. One meeting each year might be held in relation to the British Association.

Just as the Royal Society has many other functions beyond that of meeting for the reading of papers and the holding of discussions, so this new society should from the outset contemplate a fuller scope. For example, we are at the moment without any accurate knowledge on many basic facts concerning the social relations of science. What research is actually being done in Great Britain, under what conditions, and how financed? Why are some branches of research relatively neglected? What are the observable trends in the nature of research, and what can be said as to its practical results and social effects?

Numerous questions also arise concerning such matters as the organization of scientific publication and abstracting services, and what might be called the 'public relations' aspect of science.

It would seem, therefore, as if such a society should aim (*a*) at having money for research grants at its disposal, (*b*) at the organization of an information bureau analogous to the Imperial bureaux already established for pure and applied sciences.

Dr. Joseph Needham

THERE can be no doubt that the proposal to set up an organization for the study of the social relations of science will be welcomed by wide circles of people, not only in science, but also in industry and all departments of public life. For such a step the time is more than ripe.

The 'ethical neutrality' which has often, no doubt rightly, been described by philosophers as part of the scientific method, has sometimes been interpreted as meaning that it is the duty of the scientific worker to hold no views, and entertain no hopes, about the social order in which his work is done. If the scientific worker were exempted from paying income tax and enjoyed neither municipal water nor police protection, if, in fact, he were isolated from society, abstractions of this kind might be true. But it is, of course, obvious that he is a citizen as well as a scientific worker, with a citizen's responsibilities; in Great Britain, indeed, a citizen of one of the world's oldest and greatest democracies. It is his duty, therefore, to make up his mind about the uses to which his work may be put, or the failure to utilize it, and to express his conclusions in no uncertain manner.

It seems, however, an excellent plan that the publications of the proposed organization should be quite objective, providing a forum where arguments on all sides can be clearly stated. On questions such as the 'frustration' of science, the suggested moratorium of discovery and technical application, the optimum conditions for organization of research, etc., there are various points of view. Differences between these may be major or minor. But at present there does seem to be a lack of the means of ventilating these discussions, nor is it beyond the bounds of possibility that should an overwhelming case be made out for a certain line of action by papers, for example, in the proposed journal, the organization itself might sponsor, or press for, such action.

In general, however, the awakening of scientific men and others to a sense of the social relevancy of their studies to the happiness and freedom of the people as a whole will be a great achievement.

Agriculture and Geology

Sir Daniel Hall, K.C.B., F.R.S.

THE question at issue is whether it is worth while to promote the formation of a society to study the social relations of science. At the present time the man of science, perhaps more than anyone else, is conscious that the organization of society, national or international, is in need of guidance. He is also conscious that in such organization as exists, science is almost wholly ignored, though it is being used for ends which must eventually destroy science, on one hand for the intensification of the destructiveness of war, and on the other for the regimentation of public opinion and the suppression of free thought. Let us not mistake the omens—there exists in England to-day an intolerance of differing opinions and a desire to employ force against them, coupled with a contempt for science, except in its subordinate capacity to deliver 'goods', such as has never been known before in my lifetime. All the stupidities of the war-time are being revived in preparation of the war to come. What are the alternatives to the man of science? He can contrive his own personal escape, or he can join with others to promulgate his faith in the ultimate prevalence of reason and persuasion.

Can there be a society devoted to the scientific study of social relations? It may be asked, what else is a university? It should be such a society, but with all our gratitude for the free play of thought they contribute, universities actually take their colour from a relatively narrow range of society, and also in their faculties of law, literature, history and theology are trained the apologists for reaction and return to the past. In consequence, the men of science must constitute a university of their own, a research university which shall subject 'social relations' to scientific study. Such a university or society needs no buildings, but it does need money to pay its investigators. The men engaged in active scientific work can give guidance, stimulus and criticism in such a cause, but they cannot supply the time for the actual investigation.

The results may all seem futile enough—reports on subjects on which the political parties have already taken sides—but it will be proceeding by the only ultimate weapons science can use, by reason and persuasion.

Sir John Russell, O.B.E., F.R.S.

IT is very important that the social relations of science should be more fully studied. During the past eighty years, both science and our social structure have developed enormously, and changed out of all recognition. How far the scientific developments have been responsible for the social changes it is impossible to say, but it is certain that they have had profound effects, both directly and indirectly.

These indirect effects of science are probably at a minimum in the totalitarian States, where the dictator plans the life of the nation, and allocates their respective roles to the different groups of the community. Social relations are thus reduced to their simplest form: the scientific worker has no occasion to concern himself with them, or indeed with anything more than the immediate results of his work, and the dictator can proceed at once to deal with any undesirable consequences.

In a democratic country like Great Britain, the problem is far more complex, and unless it is seriously studied it may yet prove the weakness that will bring democracy down with a crash, when confronted with the superior organization of a dictatorship. Science can give vast power to any small group of people who are in a position to use it, and they may use it either for good or for ill. Almost all scientific discovery can ultimately be put to evil use: even agricultural science, most blameless of all, has been perverted to the destruction of soils that had taken thousands of years to build up.

Some of the ultimate effects of scientific discoveries on human life have been very profound, though it

would be unjust to attribute them wholly to science. Perhaps the most far reaching has been the moving away from religion as the basis of life and character that was so marked a feature of the older days. The firm belief in a just God who would redress in a future life the pains and sorrows suffered in this life undoubtedly gave our fathers a strong feeling of courage, hopefulness and optimism which many observers declare to be lacking to-day. This same belief also emphasized the responsibility of each individual for working out his own destiny, and so inspired a widespread spirit of self-reliance and sturdy individuality now much less common than it was.

Another important change has been the sweeping away of craftsmanship and the substitution of standardized machine products. It would be impossible now to build beautiful villages such as one can still find in the less known, and to use the house agents' word, 'unspoiled' parts of the countryside: and it is difficult to believe that the old craftsmen would have tolerated the blatant vulgarities proliferating in parts of Great Britain now being 'developed'.

A further consequence of the extension of the machine has been the segregation of a considerable class of people who are unsuited for industry, and who ask for nothing more than occasional unskilled work to eke out their doles, leaving them abundant leisure for the 'pictures' and football matches. They are found chiefly in the democratic countries, dictators having a short way of dealing with them, but they are a growing menace and likely to cause serious difficulties in the future.

It is safe to say that none of these developments was foreseen when science began its modern development, and certainly none was desired by the scientific workers. What further changes may be brought about and whether they are inevitable, could be discovered only by serious study, and it is eminently desirable that this should be undertaken.

Prof. P. G. H. Boswell, O.B.E., F.R.S.

Societies and committees seem to play such an active part in Western civilization that busy people may be expected to look askance at any proposal to re-orientate themselves in this respect. Yet, in the present state of human development, there can scarcely be any doubt as to the need for intensification and direction in the study of the social relations of science. Evidence of such need is seen, in fact, in the activities of the Engineers' Study Group, in the reactions of the sections of the British Association to the pressure of public opinion, and in the recent proposal of the Trades Union Congress to set up an advisory scientific committee. The question that at once presents itself is, can a new organization help forward the good work, or will progress be achieved better by the present haphazard method of disconnected discussion and dissemination by various publishing bodies?

If a Society for the Study of the Social Relations of Science could bring together results that would otherwise be scattered in sundry journals, one important plea for its establishment would be justified on the grounds of convenience. Then would arise the question of the scope of the society, a matter by no means easy to settle. Its scope, once agreed upon, would probably have to be circumscribed and quite likely in the direction of curbing the tendency to speculation which often plays a significant part in discussions of this sort. If, through the publication of papers concerned with the past, present, and possible future repercussions of science on social affairs, a balance could once be struck between unwise speculation and justifiable prevision, an important forward step would be taken. Foresight, as remarked by a well-known writer, is among the latest and most immature of mankind's attainments; certainly, from the moment early man turned from hunting to husbandry, the progress of human development (well expressed as "from the stone implement to the bank overdraft") has been characterized by increasing foresight and an urge to provide for the future. In the political sphere, the results likely to arise from individual or collective human action have necessarily long been the subject of careful thought, but this is not altogether true in regard to the results that may follow scientific discovery.

There seems, then, on the grounds of expediency alone, to be a definite case for the attempt to define the aims and activities of a proposed Society for the Study of the Social Relations of Science. The British Association is, of course, the singularly appropriate body at the present time to undertake this task, but various difficulties would require to be surmounted, including that of publication of original papers in full, if it took over the work of such a society itself.

Physics

Sir Henry Tizard, K.C.B., F.R.S.

There is nothing new in the fact that experiment and invention are transforming the habits of men and are adding to their problems. What is new is that we are all more aware of it, because the rate of change has been steadily increasing. Ease of communication, and the rapidity with which news can be conveyed throughout the world, emphasize the weak points in the social structure and tend to hide the good points. Bad news is, as a rule, better copy than good news. But can it seriously be argued that any section of society is worse off and living under worse conditions than a hundred years ago? Broadly speaking, the natural result of all scientific discovery has been greatly to improve the conditions of life and all our social relations, in spite of—or possibly even because of—the fact that scientific workers have been too busy doing their own jobs well to worry much about other people's.

Many men of science are, however, now taking a direct and vivid interest in the application of science to social problems. But it must be admitted that some of them go about the business in the wrong way. Many readers of Nature can think of scientific men who are most cautious in expressing opinions on scientific questions, who will always allow that there

is a good deal to be said for the other man's point of view, who are content to settle the points of difference by careful experiment and study, but who appear, oddly enough, to have little hesitation in making loose and insufficiently considered statements on matters of great social and political importance. They are doing science a disservice, and they ought to be discouraged. A good way of discouraging them is to encourage the sane consideration of the big social problems of the future by scientific workers working in co-operation with other men.

For this reason I think it is well worth while to try the experiment of forming a society to advance knowledge by encouraging the discussion of social science, and by the publication of articles which have had the benefit of informed criticism before they are published. The forthcoming reports by the International Council of Scientific Unions will probably be of great interest, but of very little practical value. They will doubtless contain a mass of data which may eventually be used as a basis for a first-class work by a first-class historian, but they are most unlikely to form a trustworthy guide for national or international policy, or to help to an understanding of the future effects of science on society.

Prof. J. D. Bernal, F.R.S.

SCIENCE as a factor in modern society is uncontrolled; what it does and does not do is left largely to chance and to the operations of ill-understood factors. If we are to prevent it becoming uncontrollable and destructive of the very civilization it has built up, we must begin at least to understand how science and society interact. This is why I welcome the formation of the Society for the Study of the Social Relations of Science, and hope it may find a wide support among scientific workers.

The formation of such a society is a logical step. Science has grown so great that it must take cognizance of itself. We need to create a science of science. This means taking our own activity and the social environment with which it reacts as a new field of study. No existing scientific body could undertake such a task; their fields are already too well delimited. The sociologists, economists and historians, on the other hand, although they see the wider aspects, cannot by themselves understand either the social implication of scientific or technical discovery or the social and economic conditions which are needed for their production. Only a broad body in which both sides could meet and pool their knowledge can lead to clarification and new understanding.

In the first place we want facts. We need to know the history of the relation of science to society, an aspect of history which has as yet scarcely been touched. Even more urgently do we need to know the present status of scientific research and teaching both in our own country and abroad. How many scientific workers are there? How are they financed? What do they do? How is their work co-ordinated and directed? How is it linked with the satisfaction of human needs and the removal of human evils? Until we have fairly adequate answers to these questions we have no basis for understanding the present or planning for the future. The answering of these questions, even setting them in an answerable form, is a task which should properly fall to the new society.

Research, discussion and publication would all have their place, and in that respect the S.R.S. would be fully analogous to any existing learned society. But the study of wholes is never such a simple and straightforward business as the study of parts, and it may well be that the exact modelling of the S.R.S. on existing learned societies may not be best adapted to the nature of the work it is to undertake. Only experience can decide, and it might perhaps be as well to defer the precise determination of its constitution until there has been the chance to consider the main outlines, and some of the preliminary work has been done.

Prof. P. M. S. Blackett, F.R.S.

THE suggestion that there should be formed a Society for the Study of the Social Relations of Science (S.R.S.) is greatly to be welcomed. One can see here the possibility of the growth of a society which may have a profound educative value. It is worth while, therefore, to consider at the outset some of the conditions that are likely to be necessary for this desirable end to be attained. Of course, these conditions themselves will probably be the subject of controversy. This emphasizes at once that the views expressed in communications to the society must essentially be controversial. If controversy be banned, sterility will certainly result. This raises difficulties in connexion with the proposed, and of course necessary, refereeing of papers. Though it is obviously essential to maintain a high standard in the presentation of the facts, it is equally essential to allow a wide freedom in the deductions from them. For the same social facts do not, in general, lead people of different political views to the same conclusions. If this is not admitted at the outset; if, on the contrary, following too closely the example of other learned societies dealing with more exact subjects, the S.R.S. strives after a pseudo-scientific unanimity of deduction from given social facts, then I fear little that is useful will be attained.

Closely related to this is the danger that the problem of the relationship of science and society will be too much simplified by over-emphasis on the brilliant achievements of scientific workers in their field, with the supposed incompetence of statesmen in theirs. This view is apt to lead to the naïve belief that it is only necessary to replace statesmen by men of science to put everything right—a fallacy which is quite often believed to-day, particularly by men of science.

On the positive side, it seems to me essential that the S.R.S. should have a strong historical bias, in the sense that the relationship between science and society should be considered historically in all its continually changing aspects. Special attention should be given to the reciprocal influence between social change and technical and scientific advance.

Consequently, the S.R.S. must be concerned as much with the impact of society on science, as of science on society: to separate the two is surely to miss an essential understanding of either. It is noticeable that the quotation from the resolution of the Council of the American Association for the Advancement of Science in the article on the suggested S.R.S. emphasizes only one side of this relationship.

If we are now to act usefully so as to remedy in the future our present discontents, we must not only know the facts of to-day, but we must also understand them; that is, we must know how the facts have come about. It is useful here to remember again the much quoted words of Descartes on the nature of things: "Leur nature est bien plus aisée à concevoir lorsqu'on les voit naître peu à peu en cette sorte lorsqu'on ne les considère que toutes faites."

Prof. F. A. Lindemann, F.R.S.

It is a commonplace to say that the whole circumstances of our civilization have been profoundly modified by invention based upon scientific progress. Everybody knows that greater changes were brought about during the reign of Queen Victoria than in the long interval between the coming of the Stuarts and the death of William IV. It is probably fair to say that the changes in the first twenty years of this century were as great as those which occurred in the last sixty years of the previous century; again, the last fifteen years have brought about changes greater even than those which marked the interval between the Boer War and the Treaty of Versailles.

When one observes the geometrical character of this progression and realizes the even more serious and, perhaps, sinister interventions which advances in the biological sciences almost certainly will render possible, one cannot but be anxious about the future. Our world picture has been fundamentally modified. Rightly or wrongly, the restraints of religion have been thereby to a great extent swept away. The facilities which science has provided have made it easy to substitute plausible, but superficial and often half-baked theories, and infect whole nations with beliefs and ideologies which in soberer times would have been scorned.

Whether a great deal can be done to prevent such abuses by the systematic study of the social relations of science it is not for me to say, but I am sure that all men of science will warmly welcome anything which could prevent the results of their researches being put to evil purposes, and will wish every success to any group or body of men working to that end.

Prof. H. Levy

A society for the study of the social relations of science is scientifically justifiable and socially urgent. Scientific workers, in the methods and criteria that they apply, in the range of their work, in the accumulating volume of discovery and invention that they bring forth, constitute a very distinctive section of social activity. They would be less than fully scientific if they were to remain ignorant of the social laws of change that they exemplify in their own group development. The proposal therefore implies a recognition of a shift in scientific interest from the physical and biological to the sociological. This shift has been stimulated by a sense of uneasiness prevalent to-day among scientific workers that all is not well with the way in which science is finding its application in social life. It has been argued that no scientific worker need concern himself with the social outcome of his work. Actually it is a fact that he does, and the proposal in question provides the evidence.

We are witnessing, therefore, a change in scientific focus, a change within science, the causes for which lie partly outside the narrow world of science itself. It raises again the important query, to what extent the trend of scientific development is or has always been conditioned by social forces. This constitutes one class of problem that falls within the scope of a society such as that proposed. The obverse of the picture presents the complementary problem in which science and technology as driving forces in social change have now become the causal agent, the effects of which are traceable in the social environment.

Both these studies argue the need for the exposure of social regularities of a qualitative and even of a quantitative nature, that are directly correlated with technological application. No scientific worker can deny that to clear up such issues is of first importance. No one of scientific temper can deny that many aspects of these problems form a fit and proper field for scientific study. The formation of a society charged with this specific task at a period of social uneasiness may well mark a significant departure in scientific work, as did the foundation of the Royal Society at the inception of the Industrial Revolution.

There are two difficulties that will have to be honestly faced from the beginning. First, it may be a very delicate matter on occasion to draw the line of demarcation between strictly scientific and strictly political issues in such a field. Those who turn their faces politically to the right or to the left have already formed convictions that they believe are scientifically well founded. It follows that the function of such a society must be like that of a sieve through which the scientific bases of such convictions must pass if they are to be other than mere prejudices. How, then, can this be achieved, if in fact many scientific workers, believing themselves unbiased politically, are perhaps unconscious of their own pre-judgments? In the face of this difficulty, I consider that the most suitable council for such a body would consist of a 'reasonable' group of scientifically minded people, along with 'right-' and 'left-wing' scientific men selected for their capacity to present a rational case, and for their power to subject papers presented to informed criticism. Acceptance or rejection of a paper would then depend on a capacity to convince the central section of the council of the validity of the contentions.

The second difficulty lies in the fact that the field of study would trench on those of sociologists and economists. The answer to this is that the task is a selective one, intimately bound up with the world of science, and that there is no evidence that economists

or sociologists are particularly concerned with its specific problems. It may be that physicists, chemists, engineers, biologists, and mathematicians are better qualified for this special task, in the sense that they are more familiar with its technical details.

Finally, it is desirable, because of its nature, that the society should rest on as wide a membership as possible, while its influence should expand with the quality and authority of its publications.

Prof. A. Ferguson

ONE's first reaction to the proposal to add yet another to the set of letters that the unfortunate student of public affairs must memorize is one of automatic opposition; nor is that attitude modified after close consideration of the proposals put forward. That an urgent need exists for an organization which, without shirking controversial matters, shall examine and report on, in a purely objective and disinterested fashion, the social implications of advances in science, is to-day obvious to the point of being commonplace; and we can all join in wishing a fortunate outcome of the deliberations of the—what is the jargon?—the C.S.S.R.

But is it necessary, or even advisable, to set up in Great Britain a new organization which shall be charged with the important and the urgent duties outlined? What advantage is there, in these days when men's emotions continually run away with their reason, in founding an S.R.S. "with a large individual membership, which should not be confined to men of science, though they should play the principal part in it"? Youth has its generous enthusiasms—which are sometimes ill-regulated; and a young S.R.S., formed at a time when all sorts and conditions of rival propagandists are proclaiming, now and then with borborygmic rumblings, the virtues of their wares, might easily find itself taking a wrong turning. It is a difficult and nice business, in these excited days, to found a new society having such objects in view, and prepared to discuss them in an objective and judicial fashion.

There is at least one organization in existence which has the constitution adumbrated; which is alive to the consequences of the impact of science on a perplexed and unstable world; which is changing its alignment to meet the demands of the changing times; which has experience in the use of a mechanism capable of dealing with these problems more rapidly and more efficiently than that of a new and untried organization; which is not lacking in enthusiasm for the forwarding of world peace, and for an equitable social order; and at any rate is not likely to attempt to staunch a wound in the thigh by applying a tourniquet to the ankle.

The necessity for the existence of an organization which shall inquire, in an objective spirit, into the social relations of science is patent; it is obvious, too, that rapid, effective and well-informed action is called for; but it would be greatly to the advantage of all to consider the possibilities of the adaptations of mechanisms already in being, before adding yet another to the almost crushing burden of already existing societies.

Sir Richard Paget, Bt.

As Mr. Aldous Huxley has pointed out in "Ends and Means", the wise use of men's increased knowledge and power depends primarily on their ethical and philosophical outlook. From this point of view, the scientific problems for investigation are chiefly questions of psychology (especially of mass psychology) and education.

It is obvious that impartial investigation cannot be expected in the totalitarian States, and that there is therefore a great responsibility on Great Britain, the United States, and the other countries which still preserve a measure of intellectual freedom, to point the way to a better order.

Organized research in education is greatly needed. At present education depends mainly on books—that is, second-hand observation, inference, imagination, etc. There has been little, if any, scientific study as to the effects of such second-hand education as compared with first-hand contact with Nature, craftsmanship, and contact with the real problems of life.

As to the machinery of civilization, I venture to add the following, as subjects urgently needing scientific investigation in Great Britain—either by a new organization such as the suggested S.R.S., or by an extension of the British Association, or by the new Nuffield College at Oxford:

(1) *Imperfections of the monetary system.* This at present treats money primarily as a commodity rather than as a token for real wealth, that is, goods and services. It gives undue power to 'finance' as compared with that which is given to the producers of real wealth; it hampers the free production and consumption of wealth. It allows money to be bought and sold as a commodity, and thus causes instability in price-levels, and in the rates of exchange between the currencies of different nations. It also causes such gross anomalies as the destruction of real wealth—for example, wheat, cotton, coffee, fruit, fish, etc.—which cannot be utilized by those who would gladly consume them, because no additional 'tokens' (that is, money) are made available wherewith to purchase them.

The present economic system also forces each nation to strive for a favourable balance of trade as against other nations; this in itself is a perpetual stimulus towards national hostility.

(2) *Lack of statistics.* It has frequently been pointed out that efficient production and planning for future production are hampered by lack of statistics of production and consumption. It seems probable that adequate statistics, coupled with a rational monetary system—which equated the supply of money (and credits) to the production of real wealth—would greatly facilitate such production, and would obviate the present difficulties of selling the products of industry; this would incidentally save a large part of the great expense and labour incurred in advertising and salesmanship, and release a large personnel for further productive work. In the domain of public health also, much valuable information is probably lost by the lack of systematic medical statistics.

(3) *New Inventions.* At present there is no recognized system for investigating the merits of new inventions, and for supplying the capital wherewith to try them out. The consequent hardships—to which even the best inventors have been, and still are, subject—are notorious.

(4) *Changes of employment.* The rapid changes of technique and of demand for new industries appear to necessitate a corresponding system of training employees in new techniques, so that new industries can be developed without dislocation of present personnel. Experience during the Great War showed that such changes of employment can be effected much more easily than had been anticipated. The co-operation of the trades unions would, of course, need to be secured in the investigation of this problem —as also in that of the length of notice to be given to employees in industry in terminating their employment otherwise than for personal faults or inefficiency.

Chemistry

Prof. A. C. G. Egerton, F.R.S.

"MAN learns from history that man never learns from history." Will the same be said, that man learns from science that science cannot help man? Will a sociologist of the future find that the impact of science on the social organization had been a factor contributing to the better adaptation of those organizations against debilitating, disintegrating and disruptive influences, and that there was steady progress towards a higher state of being? Or will it be said that the impact of science was to bring greater difficulties in its path than otherwise?

On the material side, there is no doubt that the necessities of life can be obtained more easily as a result of the knowledge that man has gained through science. But is this facility gained at the expense of increased difficulties of a psychological and sociological character which are not so easily attacked by the scientific method?

As a result of the application of science, the material conditions enabling a population to live within a given area can be assessed; but we have only gone a little way towards carrying into effect the available material improvements. When we approach the complications confronting us in the application of the scientific method to biological and psychological problems and their influence on sociology, the way is not so clear. What would be the effect of the prolongation of the average length of life? What would be the effect of increased leisure? What are the psychological effects of the various habits of life of civilized man? About such questions it is only possible at present to express an opinion, and no statement based on attack by the scientific method can yet be made.

Many matters in which human relationships come into play and about which action has to be taken are at present best dealt with by those responsible for government, who have the same experience towards such matters as the works technician has in applying his experience and rule of thumb methods to technical matters. Perhaps, as Ramsay MacDonald envisaged, the scientific method would eventually enter the realm of government and make the same advance as it has in the realm of technology. At present, however, the application of the scientific method to sociological problems has great difficulties.

A beginning can best be made, and has to some extent been made, by those responsible for government seeking the advice of men of science on all such matters in which their assistance can obviously be of advantage; in connexion with nutrition, prevention of disease, agricultural policy, afforestation, denudation, pollution of air and water supplies, provision of power and of heat, conservation of resources, etc.

It is often said that the scientific worker should control the application of his discoveries so that they may be used for the general good, instead of allowing them to be employed haphazard or utilized by those tendencies which egg men on to ill. As matters stand at present, it is not possible for the scientific investigator or the technician to control in what direction his work will be utilized. The man of science has less power almost than anyone towards the direction of human affairs. He is not organized, he cannot strike or lock himself out without running counter to his ideals of an unbridled curiosity into the workings of Nature, and he is as a rule too liberal-minded and disinterested to wish to keep his knowledge secret after the manner of the ancient priesthoods. On the other hand, he cannot stand by and see his work desecrated by folly, and he should have more power to enable him to help prevent such desecration. How can this be achieved?

Articles in NATURE have suggested certain ways and means. By all means let questions of what help the man of science can give be discussed, studied and reported. But committees and reports are not enough. Responsible scientific men who have achieved respect in their own particular line of work must carry the responsibility of their position and should be ready to be the link between the specialist in their particular branch of science and those who are responsible for government.

Things happen in this way at present. The Royal Society has always provided such assistance as it has been asked to give. Unfortunately, what is done is not enough. In some countries responsible men of science are taken into greater confidence as advisers and leaders in the State. It is this that has to be encouraged, rather than the setting up of a number of committees the work of which it is no one's particular interest to further. It has been unfortunate that, at a time when the achievement through science has been so great, the advice of those who have brought it about has not been more sought in matters of policy. To this day even on the boards of companies which are directly exploiting the results of scientific developments, those who have been very largely responsible for those developments are not included. The technical man is still kept in his place. In fact it is only through their own force of character that men of science and technical men have shared in the control of affairs.

Perhaps the fundamental error of these days is

that economic considerations are allowed to override all others, and at a time too when such values are not really essentially paramount, for through the command of natural resources the human requirements of life can nowadays be met (provided growth of population is to some extent controlled). Science, art and religion contain the basis of other values which must not be subservient to economic values. The pursuit of science has a value on its own account. The execution of a fine piece of experimental work or mathematical analysis has a beauty of its own, just as poetry and art have their particular appeal. It is this aspect of science which influenced such great men as Scheele and Faraday.

There must be men in each country to give effect to this sense of values. Those responsible for government should be able to consult with a permanent body, such as the Royal Society, which would be the focus of the various advisory councils needed, and the link with similar bodies in other countries. The British Association provides an adequate means for discussion of the various problems, but it is possible that executive action could best be taken through a smaller representative body such as the Royal Society, as close co-operation exists between the two organizations.

If an international council is appointed to work in collaboration with economists and politicians, I think that the appointments to such bodies should be made by collaboration between the Royal Society and the Government.

The substance of my remarks is that scientific men should be invited to take a closer and more responsible position in the affairs of State, and should be in closer touch with those responsible for government, as they were in the days of Charles II.

Prof. F. G. Donnan, C.B.E., F.R.S.

As a foreign member of the Amsterdam Academy of Sciences, I am very glad to have had the opportunity of associating myself with the action taken by that body, an action which led to the recent setting up by the International Council of Scientific Unions of a "Committee on Science and its Social Relations". There can be no doubt that this Committee is destined to carry out most valuable work, and its formation on such a secure international basis may well mark the beginning of a new era in the history of mankind.

The proposal to found in Great Britain a Society for the Study of the Social Relations of Science is one which I wish to support most strongly. The existence of such a society in this country—and of similar societies in other countries—would be the surest guarantee for the success of the great work initiated by the formation of the international committee.

The impact of science on society—to employ a now famous expression—is of two kinds. In its less obvious and yet perhaps finally most important form, it alters the general 'climate' of thought and opinion. In the nineteenth century, when steam-driven machinery in factories, steam-boats and railway trains, and the application of electrical science in the telegraph, telephone and electric light were changing the social and economic relations of people, the work of Wallace, Darwin and Huxley caused a fundamental change of general outlook. So also in the present century, with its vast organization of factory production and great power stations, its electric trains, motor-cars, aeroplanes, cinemas, radio, gramophones, etc., the great discoveries in physics, chemistry and astronomy have produced a profound effect on the general climate of opinion; whilst it is probable that the biological and psychological sciences are destined in no very distant future to effect another and perhaps still more drastic development.

It is with no intention of underrating the enormous effects of applied science on the social and economic conditions of humanity that I mention these matters. I want simply to suggest that we must pay equal attention to the influence exerted on the actions of men by the general outlook which they derive from the current scientific philosophy presented to them. It is of very great importance that this 'ideology' should be the best available.

In spite of everything that has been written on the subject, it is perhaps not yet sufficiently realized that the inhabitants of this planet are witnessing at the present time a very peculiar epoch in its history —the epoch of the enormously rapid advance of science and its applications. Although speculative prophecy is usually of small value, I am inclined to hold the opinion that this epoch will be a relatively brief one, confined (bar 'accidents' of a terrestrial or extra-terrestrial character) to the next ten thousand, or possibly the next two thousand, years. It is hard to say when the zenith of this peculiar period will be reached. Certainly nothing like it has ever been experienced before by the inhabitants of this earth. Will its effects be beneficial or catastrophic? That is the serious question to which civilized humanity is now slowly awakening. Modern science is the revelation to mankind of possibilities and potentialities undreamed of even by such giants as Galileo, Newton and Harvey—undreamed of, therefore, only a few hundred years ago. What will a Wellsian historian, writing, say, in the year 20,000, have to say of this epoch?

In the somewhat complacent mixture of romanticism and utilitarianism which characterized the nineteenth century, many men, intoxicated by the advances of that age, dreamed of a continuous upward progress of humanity. Wiser, or perhaps more disillusioned, than they, we of this century are by no means sure of such a continuous progress. Many see a possible, or even probable, danger of collapse. Such a crash of civilization could never be due to the true advance of scientific knowledge, though it might be accelerated by the inhuman and anti-social use of this knowledge, and by a false ideology based on a perverted interpretation.

I think that one of the main objects of the new society will be the careful study of the reversible social-scientific reaction, science $\rightleftarrows$ human welfare; how by the advance of science to increase human welfare, and how by the advance of human welfare to increase science. This is one of the great dynamic equilibria of a beneficent and benevolent civilization.

At the same time we must avoid the errors of an easy sentimentalism founded on august abstract nouns and grandiloquent phrases. Human society and its welfare are extremely difficult and complicated matters, the hard, concrete realities of which demand detailed and highly critical study. Although we may reject the application to human society of the holistic conceptions of the beehive and the termitory, or the idea of the flowering of a great aristocracy based on a partial de-humanization of the rest, it will be for the biological and psychological science of the future to say what are the possibilities and what may be the best available solution. Unlike traditional philosophy and traditional theology, science does not attempt to storm the citadel of truth ; it rests on patient experimental research, and offers no simple panacea and no facile Utopia. Great and immense, therefore, are the prospects and potentialities of the new society, for they will be based on the essential fluidity and adaptability of scientific thought, the steady progress of discovery, and the slow building of whatever conception of the *summum bonum* mankind is capable of attaining. There may be room here for personal optimism or pessimism, but none for tears or an inaction born of despair.

Prof. John Read, F.R.S.

THE furtherance of the ideal under discussion will depend largely upon the character of science teaching in the future. Such teaching in the past has consisted too often of a systematized inculcation of facts and theories, unillumined by any adequate reference to the bearing of these facts and theories upon everyday life, or to their influence upon the development of modern civilization. A neglect of the historical and humanistic aspect of science has been equally pronounced : incidentally, the scientific worker's neglect of history has found a counterpart in the historian's neglect of science.

A frequent consequence of what may be called the teaching of science in blinkers has been a soulless and uninspiring presentation of a vast field of human thought and endeavour which is fraught with possibilities as an instrument of education, as distinct from instruction. Dr. George Sarton has well said that "the more science enters into our lives, the more it must be 'humanised', and there is no better way to humanise it than to study its history. Such studies, reconciling the purely scientific, the historic, and the philosophic points of view, would be the source of the soundest and highest idealism." The man of science is a pioneer and an architect of human progress, and as such he should cultivate a wide vision. Only by so doing will he be able to help efficiently in building up a human society capable of appreciating the spirit and method of science, and of putting the discoveries of science to sane and effective uses.

Prof. J. C. Philip, O.B.E., F.R.S.

THE significance of scientific method and scientific discovery for social and economic conditions, national and international, is increasingly recognized, and the proposal to provide a specific forum for the exposition and discussion of the relevant problems merits cordial support. In the columns of NATURE, from time to time during recent years, the importance of these problems has been stressed, and it is entirely appropriate that the Editor should initiate suggestions for a further definite step in this matter.

Scientific men are often regarded as standing aloof from common human interests, and indeed their own attitude has frequently given support to this view. Some have been inclined to rate the value of science as inversely proportional to its utility and to the extent of its contact with the practical affairs of life. In the world situation of to-day, however, when the frequently serious economic consequences of technical development and the extensive application of scientific knowledge to destructive ends are only too evident, such a detached attitude becomes impossible for a reflecting man.

Advancing knowledge has outstripped the development of social ethics, and one feels that, however marvellous the discoveries of the last fifty years may be, their applications have in many cases provided only "improved means to unimproved ends", as Mr. Aldous Huxley has put it recently. It is time that vision and brains were devoted, not so much to the extension of the boundaries of knowledge, as to a serious and systematic examination of the problems which the discoveries of science have created.

A society for the study of the social relations of science, such as is now proposed, would provide opportunity for the dispassionate investigation of these pressing questions. Operating in conditions of objectivity and free discussion, the society should attract the sympathy and support not only of scientists but also of others to whom the welfare of the community is a major concern.

Dr. C. H. Desch, F.R.S.

THE effects produced on society by the growth of science fall into three main categories : the changes in material conditions caused by inventions ; the influence of scientific thought on the intellectual outlook ; and the increased appreciation of the mutual dependence of peoples. It is the first of these which attracts most attention, and seems to offer the most fruitful field for such an organization as is suggested, but the other two are no less important. Although the present is called the Scientific Age, mainly on account of its material achievements, it is doubtful whether current views on social questions are appreciably affected by scientific ideas. The history of scientific discovery and thought, the scientific interpretation of historical events, and the study of such concrete problems as the conservation of natural resources and their relation to international trade, fall into the third category.

In discussions on this subject, 'science' has too often meant only the physical sciences. No doubt public interest in nutrition and in eugenics has done much to bring biology into the field, whilst popular interest in psychology even proves embarrassing from its failure to distinguish science from

charlatanism, but science remains incomplete unless it includes sociology, in the Comtean sense of a synthesis of the social sciences. In the public view, its place has usually been taken by economics, which deals only with a single aspect of social life. Unless science be understood to embrace social as well as physical and biological phenomena, it would seem impossible to bring it to bear effectively on social conduct.

As science becomes more specialized, so that workers in different branches find it increasingly difficult to understand one another's language, the need for a synthetic outlook becomes more urgent. This view has been frequently expressed in NATURE.

It is regrettable that so few workers in experimental science have taken a keen interest in social science, if we except the recent enthusiasm in some quarters for the Marxian system, which exalts the economic above all other social factors. The Sociological Society (founded 1904, since 1930 the Institute of Sociology) has attracted few scientific workers, in spite of the early efforts of Francis Galton and Patrick Geddes, but it would seem an appropriate centre for discussions of the social relations of science, whilst the annual gatherings of the British Association afford an excellent opportunity for bringing results before the public. It needs to be shown that a new society, unless its programme be very carefully thought out and some guiding principle of synthesis adopted, would do the work better than existing organizations. There will be general agreement as to the need for such action as that suggested, but it is not clear that the solution proposed is the best.

Summary

THE comments in the foregoing letters may be conveniently summarized in three groups: *why* is it necessary to go deeper into the social relations of science, *what* are the activities envisaged, and *how* can they best be brought about.

The rapid and persistent growth of natural knowledge leads to effects which have to be correlated (Bragg, Fleure). There is a need for intensification and direction in the study of the social relations of science (Boswell) and guidance in the organization of society (Hall). All is not well in the way science is applied to social life (Levy). The liberty of science is threatened (Hopkins). Social developments are ill-balanced (Bartlett, Philip) and may destroy civilization (Bernal, Donnan, Kerr, Lindemann).

The social problems created by science can be solved by scientific method (Flugel) but educative action is needed both for scientific workers (Blackett) and for other citizens (Kerr). As the sciences become more specialized, the need for their synthesis increases (Desch, Salisbury, Spearman) and also that for a closer relationship between scientific and social workers (Laski, Marquand, C. S. Myers). It is the duty of scientific workers, as citizens, to study the social implications of science (Needham, Stopford) and to see that Government and legislature receive the best advice from those scientifically qualified (Egerton, Ryle).

The proposed organization would provide a meeting place between men of science and others interested in statescraft (Crew) and would prevent them from going about the business in the wrong way (Tizard). It should study the social background of science (Le Gros Clark), the historical relations between science and society (Blackett) and, in general, the reversible reaction science $\rightleftarrows$ society (Donnan). In particular, it would investigate the repercussions of science on social affairs and also likely future developments (Boswell, Russell).

As specific problems, it might find out the number of scientific workers, how they are financed and how their work is co-ordinated (Bernal, Huxley, Needham) and might draw up a code of ethics for them (Hill). The mechanism of production, the unsatisfactory method of dealing with new inventions, the imperfections of the financial system, the lack of statistics, problems of employment and ecological studies also deserve attention (Sargant Florence, Paget, Salisbury).

The organization envisaged should eventually humanize scientific teaching (Read), bring together results scattered in many journals (Boswell), act as co-ordinating body to other societies (C. S. Myers) and encourage them to study specific problems—for example, the anthropological and folklore societies might inquire into the springs of human action (Fleure). It should obtain and distribute funds for research (Huxley, Hall, Wells) and might eventually act as information bureau and consultative body for administration and industry (Flugel, Huxley).

The need for preventing unnecessary duplication is stressed, particularly with reference to the activities of the British Association, the Royal Society and the Institute of Sociology (Ferguson, Egerton, Desch). Sociologists would welcome co-operation (Farquharson) and the proposed organization might grow into a section of the B.A. (Crew).

Other than scientific workers should be welcomed as members (Hopkins, Levy, Philip, Stopford). Sociology should be well represented (Ginsberg). Representatives of the chief societies interested in social questions should be included (C. S. Myers) but membership should be individual (Haldane). Manual workers should be allowed to join (Haldane) but economic quacks should be excluded (Marquand).

Apart from one correspondent (J. L. Myres) the comments and criticisms are mostly constructive. The chief difficulties foreseen are in connexion with retaining a cool, scientific attitude towards emotional and political subjects (Ferguson, Chalmers Mitchell, Stopford) and of obtaining a fair, unbiased board of referees for the publications (Blackett, Haldane, Levy). Here, perhaps, the First Interim Report on Schemes and Proposals for Economic and Social Reforms, published by the British Science Guild and the Engineers' Study Group (see NATURE, May 25, 1935) shows that at least one group of investigators found that the problem was not insoluble.

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tions of this, his favourite, field of research, and did his best to build up really adequate series upon which future systematists could work. It will require the labour of two or three generations of systematists to exhaust the possibilities of the material now available. It is to be hoped that the Tring Museum will be carried on as a living institution and that enough neighbouring land can be acquired to admit of future extension.

Protection of Aborigines

RECENT correspondence in the Press has shown that there is a considerable body of public opinion which is still far from satisfied with the treatment accorded the races of backward civilization under British jurisdiction, notwithstanding the undoubted improvement in conditions and a more sympathetic attitude towards them to be observed in recent years. With a view to the possibility of further improvement, it has been decided by persons and organizations interested in the problem to hold a public meeting for the discussion of the question of their preservation. The meeting will be held by permission of the Council of the Royal Empire Society in the Assembly Hall of that body on April 28 at 3.45 p.m. The chair will be taken by Lord Moyne, who will speak on "Natives in the Solomon Islands". Other speakers will be Dr. W. van Waterschoot van der Gracht, president of the Pygmy Sub-Committee of the Nederlandsche Commissie voor Internationaale Natuurbescherming, on "The Preservation of Backward Primitive Races"; Dr. John R. Baker on "The Natives of the New Hebrides"; and Dr. Julian Huxley, who will deal generally with the preservation of primitive cultures. Tickets of admission, which is free, may be obtained from the Secretary, Aborigines Protection Society, Denison House, 296 Vauxhall Road, S.W.1.

Indian Cultural Studies

NOTWITHSTANDING the assurance that the Indian collections of the Victoria and Albert Museum, South Kensington, were not to be dispersed and that space would continue to be provided for them in the galleries of that Museum, which followed Mr. de la Valette's lecture before the Indian Section of the Royal Society of Arts (see NATURE, December 25, p. 1108, and January 29, p. 177), the critics of the methods of the ethnographical sections of our national collections are still of the opinion that less than justice is done to requirements for the study of the cultural history of India, compared with what might be attempted with the resources at command. A joint committee accordingly has been formed, consisting of representatives of the five bodies more intimately concerned in the study of India and her peoples. These are the Royal Society of Arts (Indian Section), the India Society, the Royal Asiatic Society, the East India Association and the School of Oriental Studies. Although the joint committee has as yet, it is understood, arrived at no decision as to its precise aims and methods of procedure, in principle the general purpose is to secure provision which in scope and display, dignity and standing, will be worthy of so great a dependency as India, with its tradition of advanced civilization stretching back thousands of years, and as the place of origin of at least one of the religious systems of the world's history. The traditions of the Victoria and Albert Museum, though it included 'industry' in its original purview, are not such as to foster a treatment of Indian culture in which technology and the humbler arts of life have no less claim, if not indeed a stronger claim, to treatment than fine art. But while the Indian collections continue to be merely a department of a larger unit, they must be subordinated to the purpose of the whole. The joint committee has been criticized, notably by the writer of a letter in *The Times* of March 23, as academic; but surely if its purpose is rightly understood, it is precisely the academic spirit which it aims to avoid. What could be more closely in touch with modern India than a comprehensive museum of Indian culture, which should cover both past and present?

University of Birmingham

AT the last meeting of the Council of the University of Birmingham, the following resolution was passed: "The Council has considered the recommendation of the Finance and General Purposes Committee with regard to the pressing needs of the Department of Physics, involving a capital outlay of about £60,000. It unanimously recognizes the urgency of the requirements, but, owing to the present state of University finance, regrets that it is not possible at present to put this work in hand. It is, however, most desirable in the interests both of teaching and research that there should be no delay, and the Council would be most grateful for any financial help from outside to enable the University to meet these requirements." This is a sequel to a report on the needs of the Physics Department made to the Council by Prof. M. L. Oliphant, who points out that the equipment and general facilities of the Department are totally inadequate for present needs. The time has come to review the temporary expedient adopted twenty years ago of having a considerable portion of the Department in old army huts.

THE scheme for extension of the Physics Department proposed by Prof. Oliphant includes an additional block which would consist of a large central research hall suitable for high-voltage work, flanked by a number of research rooms, a machine room, workshop, dark rooms and a basement room for high-energy X-ray work. The general idea is that the buildings themselves should be simple and less costly than those of the remainder of the University, and the design should be elastic to be capable of readjustment with the changing needs of physical research. The present building could then be used entirely for teaching work and accommodation of staff. Unfortunately, it appears that architectural considerations require that the frontage to the great court should be of the massive and costly type exhibited in the rest of the University building as a

whole, though the rear part radiating out behind the curved frontage might be of the relatively cheap design favoured by Prof. Oliphant. The financial stringency indicated in the resolution of the Council is due to the heavy expenditure required for the completion and equipment of the new Medical School. The needs of the University of Birmingham, particularly in such a subject as physics, should have a first call on the generosity of Midland industrialists.

Protection of Wild Fowl

THE Wild Fowl Enquiry Sub-committee of the British Section of the International Committee for Bird Protection was received on April 6 by Sir Samuel Hoare, the Home Secretary, to discuss the question of the further protection of wild fowl. The deputation, which was introduced by Mr. Perch R. Lowe, chairman of the sub-committee, included its secretary, Miss P. Barclay-Smith, and representatives of bodies interested in the preservation of wild life and of museums. The immediate object which this sub-committee has in view is to promote legislation aimed at the prevention of the importation of wild duck and wild geese into Great Britain during the close season. There is also the further question of preventing the exposure for sale of wild duck during the same period and also of extending the close season to such limits as would be in the interests of the wild duck, sportsmen, and everyone concerned. At the present moment, large consignments of wild duck are shipped from Holland to British markets during our close time, having been caught in the many decoys which that country possesses. In view of the threatened diminution of the status of wild duck brought about by the many adverse factors affecting their welfare at the present time, the commercialization in Europe of any bird habitually shot for either sport or food, or both, cannot rationally be allowed to continue during both the open and close season. It will be remembered that the present sub-committee was successful last year in getting legislation set up to prevent the importation of quail into Great Britain during the close time.

Royal Botanic Garden, Calcutta

A NUMBER of men of science from Great Britain and elsewhere who were attending the jubilee meeting of the Indian Science Congress in January last were able to be present at the celebrations of the hundred and fiftieth anniversary of the Royal Botanic Garden, Sibpur, Calcutta, a note on the history of which appeared in NATURE of January 1. Sir James Jeans, president of the Congress, congratulated the Garden on its anniversary. Sir Arthur Hill, director of the Royal Botanic Gardens, Kew, in his address, stated that it was the first time a director of the Royal Botanic Gardens, Kew, had been to India in his official capacity. Sir Arthur pointed out the similarity in position, scientific interest and æsthetic beauty between the two Gardens. He emphasized the importance of the Sibpur Garden, and expressed the hope that the Government of Bengal will recognize its importance and that the necessary funds will be forthcoming both for the maintenance of the scientific staff and for the upkeep of the living collections. Sir Arthur suggested that Sibpur should, like Kew, serve as a training ground for student gardeners, in order that the many good gardens and parks in India may be maintained at a high standard of excellence. To this end, he suggested that the practice of sending men from Kew to Sibpur as instructors or curators should be continued.

DR. K. BISWAS, the present superintendent of the Royal Botanic Garden, Sibpur, referred to the keen interest taken in its welfare by the late Sir Jagadis Chandra Bose, and also by the late Prof. Hans Molisch, both of whom frequently visited the Garden. Dr. Biswas briefly reviewed the history of the Garden, most of the superintendents of which have been botanists of eminence. Economic botany naturally takes first place in the activities of its scientific staff, and Dr. Biswas gave examples of what has been and is being done in this direction, for example, cultivation and utilization of teak, jute, cotton, flax, tobacco, rubber, coffee, cocoa, etc. The Garden also offers good scope for the study of the tropical flora; 1,500 species are under cultivation. In fact, Indian botany is offered excellent opportunity for advancement with the help of the Royal Botanic Garden, its excellent Herbarium and its Library at Sibpur, Calcutta.

British Empire Cancer Campaign

AT the recent quarterly meeting of the Grand Council of the British Empire Cancer Campaign, a further grant of £1,000 for one year was placed at the disposal of the North of England Council of the Campaign to enable the short wave investigations to be continued under the direction of Dr. F. Dickens and Dr. S. F. Evans. This work, which is a continuation of that which appeared in the last Annual Report of the Campaign and in a recent issue of the *American Journal of Cancer*, concerns the investigations of the effect of varying forms of heat upon malignant tissues. It was also decided to allot a further sum of £1,338 for one year for the extension of the national propaganda work being carried out by the Central Propaganda Committee. Sir Charles Gordon-Watson, vice-chairman of the Clinical Cancer Research Committee, reported that the organization for the statistical cancer inquiries in the teaching and special hospitals of London and the hospitals of the London County Council and the Middlesex County Council has now been completed. He stated that all these Institutions have appointed registrars to take charge of the records at their respective hospitals and that the headquarters' arrangements are being perfected to deal with the data concerning more than 17,000 new cases of cancer yearly in the metropolitan area of London. The Grand Council confirmed the recommendation for the appointment in the near future of a full-time medical secretary and registrar at headquarters for this purpose.

Civil List Pensions

THE following pensions, among others, were granted during the year ended March 31, 1938, and are payable under the provisions of the Civil List Act, 1937, whereby the total amount has been increased from £1,200 to £2,500: Miss Alice Mary Buckton, in recognition of her services to literature and of the services rendered by her father, the late Mr. George B. Buckton, F.R.S., to entomology (£50 additional to the previous pension of £60); Mrs. Agnes Maud Carey, in recognition of the inventions of her husband, the late Mr. Robert Falkland Carey, in connexion with the discharge of aeroplanes from ships (£25 additional to the previous pension of £75); Miss Evelyn Marie Jeanette Dupré, in recognition of the public and scientific services rendered by her father, the late Dr. A. Dupré, F.R.S. (£75); Dr. Frank Elgee, in recognition of his services to archæology and geology (£130); Miss Alice Everett, in recognition of her own and her father's services to physics and other branches of science (£100); Miss Rachel Mary Fleming, in recognition of her services to anthropology and geography (£20 additional to the previous pension of £80); Prof. James John Guest, in recognition of his services to science (£100); Sir James Marchant, in recognition of his public and social services (£30 additional to the previous pension of £75); Mr. James Reid Moir, in recognition of his services to prehistoric archæology (£110); John A. J. Starkey, Marjorie M. J. Starkey, Jane R. Starkey (during the minority of any one of them), in recognition of the services rendered by their father, the late Mr. James Leslie Starkey, to archæology (£210 in trust).

Announcements

THE Linnean Gold Medal for 1938 of the Linnean Society of London has been awarded to Sir D'Arcy Thompson, professor of natural history in the University of St. Andrews.

SIR DAVID PRAIN has been appointed president for life of the Imperial College of Tropical Agriculture. Sir David, who celebrated his eightieth birthday on July 11 last (see NATURE, July 17, 1937, p. 98), was director of the Royal Botanic Gardens, Kew, from 1905 until 1922. He was a member of the Tropical Agricultural College Committee appointed by Lord Milner in 1919 and had been vice-chairman of the Imperial College of Tropical Agriculture from its foundation in 1921 until last year, when he retired. His appointment as life-president of the College is a particularly fitting honour which, it will be the general wish of all scientific workers, he may enjoy for some years.

SIR MERRIK BURRELL has been awarded the Gold Medal of the Royal Agricultural Society for distinguished services to agriculture. Sir Merrik was president of the Royal Agricultural Society and chairman of the Council of Agriculture for England in 1936, and for many years was chairman of the Society's committee which founded and administered the London Quarantine Station before it passed into the control of the Ministry of Agriculture.

WE regret to announce the death of Mr. J. E Marsh, F.R.S., demonstrator in the University Museum, Oxford, from 1886 until 1930, on April 13, aged seventy-seven years.

ON April 17, a new British record for gliding was made by Mr. C. Nicholson, who flew in his Rhönsperber sailplane from Huish (Wilts) to East Bigbury, near Plymouth, a distance of 122 miles. The previous record was held by Mr. P. A. Wills, who flew 104 miles from Dunstable to Pakefield on July 5, 1936 (see p. 714). On April 18, Mr. J. S. Fox broke Mr. Nicholson's record by flying in his Rhönadler sailplane from Huish to Fowey, Cornwall—a distance of 144 miles.

THE British Association announces that Charles Darwin's home, Down House, Downe, Kent, and the gardens and grounds, are open from 10 a.m. until 6 p.m. daily until September 30, including Sundays. Admission is free.

THE annual Congress of the Ophthalmological Society of the United Kingdom will be held at the Royal Society of Medicine, 1 Wimpole Street, W.1, on April 28–30, under the presidency of Dr. Gordon Holmes. Further information can be obtained from the Secretary, 7 Queen Street, W.1.

THE sixteenth International Congress of Physiology will be held at Zurich on August 14–18 under the presidency of Prof. W. R. Hess and will consist of six sections devoted respectively to general and comparative physiology; biophysics; biochemistry; applied physiology (sport, aviation); psychophysiology; pharmacology. Further information can be obtained from Prof. Rottler, Sonnenweg 6, Basle, Switzerland.

AN earthquake of moderate intensity was recorded at Kew Observatory on April 13. The first movement reached Kew at 2 hr. 49 min. 23 sec. G.M.T. and the records indicated that the epicentre was 1080 miles away, probably in southern Italy.

A UNIT for clinical research in surgery has been established at Edinburgh by the Medical Research Council, acting jointly with the Royal Infirmary, the University, and the Royal Hospital for Sick Children. The unit will be located in the Infirmary, with facilities also in the University Department of Surgery and at the Hospital. The director is Mr. W. C. Wilson, who has for this purpose been appointed to the whole-time staff of the Council. The arrangement has at present been made for a period of five years, as from April 1, 1938. The establishment of 'units' or departments of this kind in selected hospitals forms part of a policy adopted by the Medical Research Council for the promotion of research work in clinical science, as opposed to the laboratory branches of medicine.

ERRATUM. In the letter entitled "Occurrence of the Freshwater Medusa, *Craspedacusta sowerbii*, in Eastern Canada" by the late Prof. H. B. Fantham and Dr. Annie Porter in NATURE of March 19, on p. 515, col. 2, line 26, for 1938 read 1937, and on p. 516, line 37, for 32·03 read 32·30.

Letters to the Editor

The Editor does not hold himself responsible for opinions expressed by his correspondents. He cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 753.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

Recent Solar Eruptions, Auroras, and Magnetic Storms

IN connexion with the aurora of January 25–26, 1938, discussed in detail in NATURE of February 5, p. 232, it may be of interest to report that a brilliant and prolonged solar eruption and an unusually severe radio fade-out were observed at the Commonwealth Solar Observatory, Canberra, on January 24.

Owing to cloudy weather, the first spectrohelioscope observation of the day was not made until 1512 Eastern Australian Standard Time (0512 G.M.T.; all times which follow are G.M.T.). An exceptionally large eruption was then seen to be in progress around the large spot group at 22° N., 80° W.; from then until 0700, when the intensities were still high, observations were made through breaks in the clouds. No abrupt changes in intensity corresponding to the maxima observed in the aurora were noted, although curved prominences, similar to Pettit's Sunspot Type[1] (Class 3*b*), developed between 0519 and 0540.

One of the severest short-wave radio fade-outs ever recorded with the Observatory automatic *P'f* equipment began at 0250. The ionospheric echoes during the morning were fairly normal, but disappeared suddenly at 0250, and no further echoes were recorded until 0645 when weak reflections from the F_1 region were observed. A further fade-out of signals occurred at 0700, followed by a rapid increase to normality by 0745. From previous experience of the correspondence between bright hydrogen eruptions and radio fade-outs it appears almost certain that the large eruption first seen with the spectrohelioscope at 0512 actually began a few minutes before 0250 G.M.T.

During a period of more than eighteen months of observations with the spectroheliosope, we have found that, whereas a severe eruption is frequently followed by a number of small eruptions around the same spot group, on no occasion has it been followed within a few hours by another large eruption. Hence it appears likely that the remarkable aurora of January 25 was connected with the unusually prolonged period of intense solar activity commencing about 0250 described above, rather than with a later eruption occurring after sunset here.

The interval between the beginning of the earlier eruption and the reported time of commencement of the auroral display was 39 hours (or 35 hours if the very much smaller and later eruption at 0700, indicated by the radio observations, be taken as the time of the eruption responsible). The magnetic storm which accompanied the auroral display was reported[2] as commencing at 1151 G.M.T. on January 25. The interval between the beginning of the eruption and the outbreak of the magnetic storm was thus 33 hours, although the storm did not become intense until 1730, corresponding to an interval of 38½ hours. These times are considerably greater than the average (about 26 hours) given by Hale[3] for the interval between solar eruptions and corresponding magnetic storms and auroras. It would thus appear that the velocity of projection of particles at small angles to the sun's surface is considerably less than that along the normal.

The magnetic storm recorded at Abinger[4] at 22½ hr. on January 16 can be satisfactorily related to solar activity occurring earlier on that date. No spectroheliosope observations were possible at Canberra on that day; but a severe fade-out, commencing at 0040 G.M.T. and lasting several hours, indicated without doubt the occurrence of a major eruption, probably connected with the same spot group then 30° E. of the central meridian, commencing at that time. The time interval in this case is 22 hours. This group, then 34° W. of the central meridian, was also very active on January 20–21. From the first spectroheliosope observation at 2314 on January 20, until 0125 on January 21 there was considerable activity. At 0202 an eruption of importance 2 on the I.A.U. scale was in progress, the intensity gradually decreasing until conditions approached the normal at 0240 G.M.T.

The radio observations showed abnormally poor reflection conditions from 1950 January 20, culminating in a fade-out at 0150 January 21. A further fade-out of short duration occurred at about 0715 G.M.T.

An aurora was observed just after dusk at Canberra, at 1030 on January 22, although it probably began some considerable time before it was first noticed. An intense magnetic storm began at approximately 0500[4] on the same day. Although the connexion here is not quite so definite, it seems probable that the corresponding time lags, taking the radio fade-out times as indicating the commencement of the eruptive activity, were either 32½ or 27 hours for the aurora (though this time may be too great by a few hours) and 27 or 21½ hours for the magnetic storm.

A. J. HIGGS.
R. G. GIOVANELLI.

Commonwealth Solar Observatory,
Canberra.
March 18.

[1] *Astrophys. J.*, **84**, 332 (1936).
[2] *C.R.*, **203**, 357 (1938).
[3] *Astrophys. J.*, **73**, 402 (1931).
[4] NATURE, **141**, 192 (1938).

Eddington's Fundamental Equation

IT is well-known that Eddington has obtained the equation[1]

$$10\,m^2 - 136\,m.m' + m'^2 = 0 \quad . \quad . \quad . \quad (1)$$

where m' is the mass of a 'scalar particle', that is, a particle the expectation values of the spin and charge of which are zero, and m the mass of a charged particle with spin h/2. The two values of m are shown to be associated respectively with the two signs of the charge, and writing them as m_p and m_e, we have

$$m_p : m' : m_e : : 1847{\cdot}6 : 135{\cdot}9 : 1.$$

Now the only property of the scalar particle that Eddington has used is that it may be described by a scalar strain vector, for which all the coefficients except s_{16} (the probability density) are zero. He saw that such a strain vector could be used to describe our knowledge of a particle when no observation of its charge or spin had been made, and so wrote that the scalar particle is "a particle which (so far as our information goes) has equal probability of being a proton or electron and equal probability of either direction of spin . . . a mathematical fiction, having no counterpart in experimental physics"[2]. However, it is not necessary to regard the scalar particle in this way, for it may be treated as a particle with as much independent existence as is usually ascribed to the neutrino. Then, according to Eddington's theory, it must have zero charge and zero spin (so that it may be represented by a scalar strain vector) and a mass $m' = 135{\cdot}9\ m_e$ in order to satisfy (1). If this particle were to combine with an electron or positron with the emission of a neutrino, it would yield a heavy negative or positive electron obeying Bose statistics and with mass between 136 and 137 times that of an ordinary electron.

This result is so closely in agreement with the U-particle theory of Yukawa[3], Bhabha[4], and others, which is in turn supported by facts, so far as present experimental accuracy goes, that it seems very unlikely that equation (1) can be fundamentally wrong, even although the way in which it is obtained is difficult to understand. That the equation should give, in addition to the mass ratio of the proton and electron, the right order for the mass ratio of the electron and a neutral spinless particle (and this before the heavy electron theory was put forward) suggests that Eddington's theory merits more attention than is usually given to it.

H. C. CORBEN.

Trinity College,
Cambridge.

[1] "Relativity Theory of Protons and Electrons" (Camb. Univ. Press, 1936.) Equation (12.47).

[2] "Relativity Theory of Protons and Electrons", p. 89.

[3] Yukawa, *Proc. Phys.-Math. Soc. Jap.*, **17**, 48 (1935).

[4] Bhabha, NATURE, **141**, 117 (1938).

X-Ray Study of Thymonucleic Acid

A FEW years ago an occasion presented itself of examining by X-rays a small specimen of sodium thymonucleate kindly provided by Prof. W. J. Schmidt[1] of Giessen, and an imperfect fibre photograph was obtained with a strong period along the fibre axis of about 3½ A.; but the observation was not followed up at the time. We have now continued the investigation with material prepared in the Department of Chemistry of the Caroline Institute, Stockholm, by the method of Hammarsten and Bang[2]. The viscosity and double refraction of flow of this material in aqueous solution were the subject of a recent communication in NATURE by Signer, Caspersson and Hammarsten[3].

Films of sodium thymonucleate stretched some 250 per cent have been found to give a striking, though still rather obscure, X-ray fibre photograph in which by far the most prominent reflection corresponds to a spacing along the fibre axis of 3·3₄ A., *which is almost identical with that of a fully extended polypeptide chain system*, such as β-keratin[4] or β-myosin. The true period along the fibre axis is much greater than this—perhaps seventeen times as great, to judge by the present photographs—and there are also side spacings up to about 26 A., the best defined being one of approximately 16·2 A.

In view of the hydrodynamic and optical properties of the solutions[3] and of the optical properties of the solid fibres[1], the natural conclusion from the X-ray data is that the spacing of 3·3₄ A. along the fibre axis corresponds to that of a close succession of flat or flattish nucleotides standing out perpendicularly to the long axis of the molecule to form a relatively rigid structure, strongly optically negative, and showing double refraction of flow. At first sight the distance 3·3₄ A. between successive nucleotides might seem improbably small, but it is confirmed by the high density, which is 1·62–1·63 gm./c.c. for the dry substance. (Compare the density of ascorbic acid, 1·74, the flat molecules of which are piled together at an even smaller distance (3·16 A.)[5]). The average weight of a sodium nucleotide is roughly 330, whence if A be the average area:

$$3{\cdot}34 \times A \times 1{\cdot}62 = 1{\cdot}65 \times 330 \text{ (approx.)};$$

which means that the average area per nucleotide should be about 100 A.², as it clearly must be from known interatomic and intermolecular distances (a plausible estimate for the purine nucleotides gives something like 15 × 7½ A.²). Again, the X-ray data lead to an estimate of the molecular weight (between 500,000 and 1,000,000) similar to that already arrived at by other methods[3]; for we may assume an effective average width of the molecule in solution of about 20 A., and therefore from the hydrodynamic data, which indicate a length to width ratio of roughly 300 : 1, infer a length of the order of 6,000 A. Such a length would contain some 2,000 nucleotides of thickness 3·3₄ A., and so would agree well with the weight just quoted.

The significance of these findings for chromosome structure and behaviour will be obvious. It seems difficult to believe that it is no more than a coincidence that thymonucleic acid consists of a long succession of nucleotides spaced at a distance so nearly equal to that of the long succession of amino-acid residues in a fully extended polypeptide. Rather is it a stimulating thought that probably the interplay of proteins and nucleic acids in the chromosomes is largely based on this very fact, and that some critical stage in mitosis, involving elongation of the protein chains, is realized in close co-operation with the dominating period of the interacting nucleotides.

We should like to express our indebtedness to Prof. Hammarsten and Dr. Caspersson of the Caroline

Institute for preparing for us the experimental material and for biochemical data.

X-ray examination of other nucleic acids and polynucleotides is in progress.

W. T. ASTBURY.
FLORENCE O. BELL.

Textile Physics Laboratory,
University of Leeds.
March 25.

[1] Cf. Schmidt, W. J., "Die Doppelbrechung von Karyoplasma, Zytoplasma und Metaplasma" (Berlin, 1937).
[2] Hammarsten, E., *Biochem. Z.*, **144**, 383 (1924).
[3] Signer, R., Caspersson, T., and Hammarsten, E., NATURE, **141**, 122 (1938).
[4] Cf. Astbury, W. T., NATURE, **140**, 968 (1937).
[5] Cox, E. G., NATURE, **130**, 205 (1932). Cox, E. G., and Goodwin, T. H., *J. Chem. Soc.*, 769 (1936).

Structure of Metals

IN the note by Dr. A. Müller[1] with the above title, the scatter of spots in high-dispersion X-ray photographs was interpreted as indicating variations in lattice constant of individual crystals of the order of 1/1000 to 1/2000.

Prof. W. L. Bragg and H. Lipson[2] afterwards advanced the tentative explanation of the effects observed by Müller without making the deduction that the lattice constant varies. The scatter of spots in stationary photographs deduced from the effect shown by Prof. Bragg and Lipson is equivalent to a $\triangle d/d$ value of 1/2000 approximately, for l equal to 10^{-4} cm.

There are two further effects which can give rise to scatter of spots from grains of identical lattice constant. (1) A purely geometrical effect due to the finite convergency of the X-ray beam. (2) The fact that the $K\alpha$ lines have a finite width. The first effect, the purely geometrical effect, can give rise to an angular scatter of spots which for a given constant diameter of pinhole or diaphragm becomes less as the specimen to film distance increases, provided a focusing technique is utilized; for example, pinhole, diffraction line and specimen surface lie on the circumference of the same circle.

If a reference sphere is drawn, it is easily seen that a reflection is possible provided the normal to the set of planes giving the reflection lies within a band which is determined by the maximum angle of convergence of the incident X-ray beam subtended at the specimen surface. Furthermore, the reflection spots themselves can be within a band of similar angular width. The angular width of this band, $\triangle\omega$, or what is the same thing, the possible scatter of the reflection spots from crystals of identical lattice constant, is given by

$$\triangle\omega = \frac{\text{diameter of pinhole}}{\text{specimen-diaphragm distance.}}$$

Such a scatter might erroneously be taken as arising from a variation in lattice constant which for normal cameras of 5–10 cm. film-specimen distance can amount to 1 part in 1000 to 1 part in 2000.

Dr. Müller has kindly informed me that his high dispersion photographs were taken at 30 cm. with a 0·3 mm. pinhole. The purely geometrical scatter accounts only for a variation $\triangle d/d = 1/20{,}000$ approximately and does not explain Müller's result.

The second effect, the more important effect, is that due to the finite width of the $K\alpha$ lines usually used; it does not depend on the geometry of the camera system, though it must be considered in conjunction with the geometric effect in determining the conditions in which α_1 and α_2 reflections may intermingle.

Values for the half value width $\triangle\lambda$ of the K lines of copper, iron and cobalt taken from Compton and Allison[3] are as follows:

Full width at half max. of $K\alpha$ lines.

Element	Line	Wave-length in X.U.	$\triangle\lambda$ in X.U.	$\triangle\lambda/\lambda$
Iron	$K\alpha_2$	1936	1·18	1/2000 approx.
	$K\alpha_1$	1932	1·02	"
Cobalt	$K\alpha_2$	1789	0·95	"
	$K\alpha_1$	1785	0·82	"
Copper	$K\alpha_2$	1541	0·77	"
	$K\alpha_1$	1537	0·58	"

This definite half-value width would account for variations in angular scatter of spots from crystals of identical lattice spacing equivalent to $\triangle d/d = 1/2000$ as an upper limit, whilst since the half-value width is purely an arbitrary method of estimating line width, spots could occur possibly even down to $\triangle d/d = 1/1000$.

It is of special importance to take these effects into account when using rotating or oscillating film back reflection methods of determining lattice constants, as in internal stress measurements; that is, one must average over a large number of spots, otherwise serious errors in lattice constant and in internal stresses deduced will result.

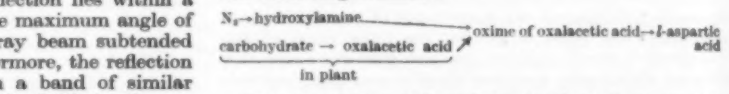
R. A. STEPHEN.

X-Ray Service Laboratories,
Philips Lamps, Ltd.,
London.
Mar. 21.

[1] NATURE, **140**, 1012 (Dec. 11, 1937).
[2] NATURE, **141**, 367 (Feb. 26, 1938).
[3] "X-Rays in Theory and Experiment", by Compton and Allison.

Biological Synthesis of Amino Acids from Atmospheric Nitrogen

SYMBIOTIC nitrogen fixation in leguminous root nodules proceeds, according to our conception, in the following manner:



This conception is based, in the first place, on the investigation of excreted nitrogen compounds from the root nodules. In extreme cases up to 80 per cent of the total fixed nitrogen is excreted into the medium from the root nodules during the growth of the pea. This nitrogen is, as regards a small part, oxime-nitrogen (usually 1–2 per cent of the total nitrogen) but mainly amino nitrogen, belonging to *l*-aspartic acid and to its decomposition product β-alanine (not to lysine, as we first assumed). As the legume bacteria decarboxylate *l*-aspartic acid forming β-alanine, *l*-aspartic acid is the first amino acid excreted[1]. Its excretion from young nodules in large amounts proves that it is formed in nitrogen fixation as a primary amino acid, from which other amino acids are then formed.

In investigating the further transformation of *l*-aspartic acid in the host plant, it has been noted that if *l*-aspartic acid and, for example, pyruvic acid, are added to the mass of crushed pea plants, the amino

group is transferred from aspartic acid to pyruvic acid, whereby α-alanine is formed, thus :

l-aspartic acid + α-keto acid → oxalacetic acid + α-amino acid.

In three hours the reaction is already far developed. The alanine was determined by extracting it from the reaction mixture with butyl alcohol and thereupon oxidizing it with ninhydrin to acetaldehyde. The transfer of amino group to α-keto acids in the plant is similar to that shown by Braunstein and Kritzman[2] in animal tissues.

The formation of aspartic acid as the only primary amino acid in nitrogen fixation is surprising. The dicarbonic acids of 4-carbon group thus attain a central position in the synthesis of amino acids. Oxalacetic acid which, according to our theory, is the acceptor to hydroxylamine, is found in considerable quantities both in pea plants and in red clover, from which we have up to the present determined it. Since the hydroxylamine reacts with the oxalacetic acid already in very dilute solutions almost immediately, it is clear that free hydroxylamine cannot be detected in the root nodules. The isolation of the oxime indicates, however, the course of the reaction. The oxime isolated as an excretion product, precipitates according to Foreman and thus apparently is the oxime of oxalacetic acid.

The reason why the hydroxylamine in the nodules reacts only with oxalacetic acid and not with other aldehydes or ketones is that the reaction with oxalacetic acid occurs at a much higher rate than with other keto acids investigated by us. In neutral solutions, each containing 0·2 millimols of oxalacetic acid, ketoglutaric acid, or pyruvic acid as sodium salts, the rate of reaction of hydroxylamine with oxalacetic acid was about seven times greater than with ketoglutaric acid and about fourteen times greater than with pyruvic acid. No reaction can be observed with glucose and fructose in such dilute solutions during 2 minutes' experiment time.

ARTTURI I. VIRTANEN.
T. LAINE.

Biochemical Institute,
Helsinki.
March 15.

[1] *Suomen Kemistilehti*, **10**, 32 (1937). *Enzymologia*, **3**, 266 (1937).
[2] NATURE, **140**, 503 (1937).

The Most Probable Place of Location of the Genes in the Chromonemata

GENETIC investigations during the last three decades have supplied evidence that the genes are located linearly in the chromosomes. Cytological studies of the meiotic prophases showed that the chromonemata are differentiated in length, consisting of chromomeres. Cytological studies on the salivary gland chromosomes in many insects and especially in *Drosophila* disclosed a discoid structure of the chromosomes. "From the differential staining behaviour of these chromatin disks one can conclude that they are or contain chemical compounds of diverse nature"[1].

The differentiation of the chromonemata in the somatic cells in plants has offered somewhat greater difficulties. Recently, I succeeded in preparing preparations from *Triticum Timopheevi* root tips in which the chromomere structure of the chromatids during the late prophases and early metaphases was very distinctly disclosed. In a number of chromatids the chromomeres were much more closely arranged at the distal ends of the chromosomes, thus forming the heterochromatic regions[2]. In *Drosophila* the heterochromatic regions are poor or devoid of genes[3,4]; therefore they are called inert regions.

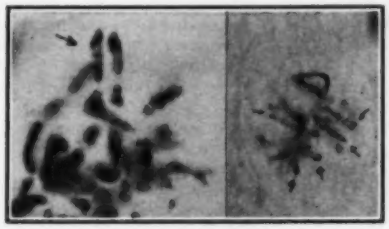


Fig. 1.

PHOTOMICROGRAPHS FROM THE ROOT TIP CELLS OF *Triticum Timopheevi*. CHROMOMERES IN THE CHROMATIDS ARE MARKED.

If we may use the differential staining for diagnosis of heterochromatic (inert) regions, as we seem to have good reasons for doing, we can conclude that heterochromatic regions are rich in chromomeres, but poor

Fig. 2.

(*a*) THE LONGER ARM OF ONE CHROMOSOME; *d*-DISTAL AND *p*-PROXIMAL ENDS. (*b*) A WHOLE CHROMOSOME. DARKER REGIONS CAN OFTEN BE SEEN AT THE DISTAL ENDS; THEY ARE USUALLY DUE TO CLOSER ARRANGEMENT OF THE CHROMOMERES, THOUGH SOMETIMES THESE CHROMOMERES ARE SOMEWHAT LARGER.

in interchromomeric substances. If the genes were located in the chromomeres, the heterochromatic regions should be active, but since they are inert, the genes should be located then between the chromomeres.

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Institute of Genetics,
Academy of Sciences of U.S.S.R.,
Moscow.
March 1.

[1] Kostoff, D., *J. Heredity*, **21**, No. 7 (1930).
[2] Kostoff, D. [NATURE, **141**, 690 (1938)].
[3] Muller, H. J., and Gershenson, S. M., *Proc. Nat. Acad. Sci.*, **21**, No. 2 (1934).
[4] Prokofieva, *Bull. Acad. Sci., U.S.S.R.*, 394 (1937).

Function of the 'Fossula spongiosa' or Spongy Furrow in Reduviidæ (Rhynchota)

So far as is known, the majority of Reduviidæ are predators of other insects, and consequently their anterior legs in particular, with the median legs, are of utmost importance in assisting them to capture their prey, especially when it is an active insect. But, in spite of their predaceous habits, it is perhaps remarkable that few Reduviidæ, with the exception of the sub-family Emesinæ and the Old World genera, *Irantha*, *Polydidus* and *Scipinia*, possess anterior legs of the raptorial type.

Very considerable diversity of structure, however, is exhibited by the anterior tibiæ of various genera, which may be thickened apically, dilated for the greater part of their length, provided with single or multiple spines, or may be of a simple type. In many species the anterior tibiæ and sometimes the median tibiæ also are provided, on the inner surface, with a sulcate or flat area of very dense short setæ. This area may be short or may cover at least half the tibiæ of the anterior legs, but is always short on the median tibiæ.

This area is referred to as the 'fossula spongiosa' or 'spongy furrow', a term which, however, is not entirely accurate for, as stated in the previous paragraph, it is not always sulcate, but is more or less flat and, in fact, may have a narrow raised area throughout longitudinally.

The origin of the term 'spongy furrow' is obviously due to the fact that the examination of most Reduviidæ has been restricted to dried specimens, and it is when they are in this condition that the structure on the tibiæ appears sulcate. In some species the 'spongy' area on the anterior tibiæ is produced, and extends to about the middle of the tarsus.

In the blood-sucking Reduviid *Rhodnius prolixus* Stål, the 'spongy furrow', which is small and present on the anterior and median tibiæ, has been considered to be a climbing organ by Gillett and Wigglesworth[1], who based their conclusions on the fact that the adult *Rhodnius* were able to climb the glass walls of the jars in which they were confined. Larval *Rhodnius*, they stated, were unable to do so. According to these investigators, in the living *Rhodnius* the organ is "an elastic sac distended with fluid". In dried specimens, however, it is shrunken and depressed.

Now, the localities which this species of *Rhodnius* inhabit are roughly constructed mud and thatch huts, an environment in which they are able to move about freely without the aid of a specially adapted climbing organ. The absence of the 'pad' from the tibiæ of larval *Rhodnius*, which would require it equally as would the adults, if it were a climbing organ, since they inhabit the same localities, indicates that the structure is not for that purpose. Those Reduviids to which a climbing organ might be advantageous, such as the Malaysian genera *Ectinoderus* and *Amulius*, frequenters of trees up which they climb, possess tibiæ devoid of a 'spongy furrow'; and furthermore, it is noteworthy that they cover the anterior pair thickly with resin to aid them to capture their prey, which consists largely of small bees of the genus *Melipona*. A 'spongy furrow', if it were present, would in this case be rendered ineffective as a climbing organ by the resinous covering.

Some other Old World genera, namely, *Sycanus* and *Cosmolestes*, as far as observation goes, prey principally on the relatively sluggish larvæ of Lepidoptera, to find which they are obliged to climb about on plants. From these genera the spongy furrow is absent.

In my opinion, it would seem therefore that the function of the 'spongy furrow' is not for the purpose of assisting the insect to climb but to enhance the gripping power of the tibiæ when the prey is captured. Further investigations may show that the degree of development of the furrow is related to the degree of toxicity of the saliva injected into the prey when captured, higher gripping qualities being combined with a less toxic or less rapidly acting fluid.

It should also be pointed out that a feeble development of the 'spongy furrow' is common when the anterior femora and tibiæ are provided with spines. In the case of *Rhodnius*, the 'spongy furrow' should probably be considered a vestigial organ, as it would be of no assistance to the bug when attacking man.

N. C. E. MILLER.

Department of Agriculture,
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Federated Malay States.

[1] "The Climbing Organ of an Insect *Rhodnius prolixus* (Hemiptera, Reduviidæ)", *Proc. Roy. Soc.*, B, 111 (1932).

Modern Studies of the Foraminifera

MAY I suggest that an opinion may be arrived at regarding modern studies of the Foraminifera other than that given in NATURE by Mr. E. Heron-Allen?[1]

Mr. Heron-Allen deplores the amount of literature published on the Foraminifera of late years, and of the number of families, genera and species described therein as new. I cannot see any escape from this result when an increased number of persons studies any group, in this case on account of its fairly recently recognized economic importance, the Foraminifera now being largely used as horizon markers in oilfield geology. Of the fact that it is often not possible to identify one's specimens with described material, there may be instanced the considerable number of forms described as new in some fifty valuable monographs and papers on the group by Mr. Heron-Allen himself, usually in collaboration with Mr. Arthur Earland.

I cannot appreciate that this is anything extraordinary, or that it differs from the modern tendency in other branches of zoology. For example, the number of described insects is colossal, and the estimated number yet undescribed is vaster still. Why, then, should one be aghast that detailed work on the Foraminifera (which often swarm in myriads), of areas and geological formations in which they may have been hitherto completely unknown, should yield many new forms? The point that new names are often given unnecessarily is as old as the subject; it may be worse now, partly on account of the difficulty of keeping pace with the new literature, particularly when papers are written in places where adequate access to it is impossible.

Mr. Heron-Allen referred (136, 132; 1935) to "the great *scientific* Foraminiferists" of old, implying that the work of modern students of the group is not scientific. As a general statement neither claim is acceptable. It is clearly impossible to make an analysis of the literature to decide what is "scientific" and what is not, and the selection of particular modern work to illustrate the point might be invidious. But in my opinion, and without denying the poor quality of some, there is much work of the post-War period that is fully up to the standard of any of that of Mr. Heron-Allen's 'giants'.

On the other side of the picture, two of Mr. Heron-Allen's examples of the "great *scientific* Foraminiferists" are Terquem and Haeusler. Terquem's fourteen monographs on the Jurassic Foraminifera form one of the most appalling examples of species-making in the whole of the literature. In these, according to my notes, he proposed no fewer than 682 new trivial names, very many of which appear to be redundant. Haeusler, on the contrary, in his sixteen

monographs and papers, also on the Jurassic Foraminifera (omitting his first paper, which his later work did not confirm), proposed only some 34 new names all told, preferring to identify many of his specimens with forms described from Tertiary and Recent material.

Were the works of these two authors to be held up as models, the future of the systematic study of the group would be black indeed.

It is concluded that modern work on the Foraminifera is very like that of those who are now dead: it is either good, bad or indifferent. The difficulty is that there is more of it to cope with.

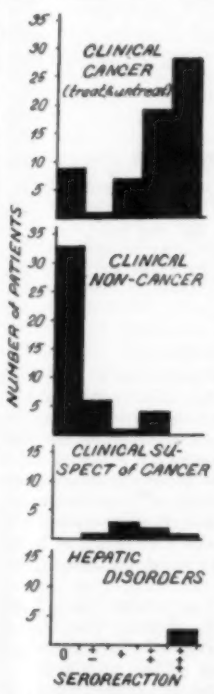
W. A. MACFADYEN.

Longships,
Capel-le-Ferne,
Folkestone.
March 28.

[1] NATURE, **134**, 43 (1934); **136**, 132 and 797 (1935); **141**, 558 (1938).

The Prague Sero Reactions for Cancer

Waldschmidt-Leitz[1], Brdička[1,2] and collaborators have recently published preliminary notes on sero reactions for cancer; they measured the activation deactivation of certain enzymatic processes or examined by the polarograph the reactions of certain catalytic processes after addition of serum or peptidized serum from men or animals with or without cancer, and ascribed the difference in action of cancer sera and non-cancer sera to differences in concentration of active S—S groups.



After a visit (by H.) to the institutes in Prague, where the workers in question kindly demonstrated the technique and material, we have carried out the sero reactions according to Brdička's polarographic methods[2,3] on sera from 118 patients: 44 without clinical symptoms of cancer, 7 with symptoms suspect of cancer (2 rough hypertrophia prostatæ with 'lumbago'), 1 anæmia simplex with achylia gastrica (61 years old), 1 cardiospasm, 1 agglutinatio vaginæ with fluor (72 years old), 1 cancer uteri incipiens (?), and 1 chronic icterus, suspect of cancer pancreatis (80 years old); 64 with clinically manifest cancer, and 3 with parenchymatous hepatic disorders (1 intoxication with sanocrysin, 1 intoxication with iodine and 1 with statis hepatis e morbu cordis incompensata).

For the reactions we have used two preparations:

(*a*) To 5 ml. of 0·05 *N* hydrochloric acid containing 5 mgm. pepsin, 0·2 ml. serum was added. The mixture was incubated at 40° C. for 20 minutes and then 0·2 ml. was withdrawn and added to 10 ml. of 0·0016 *N* cobaltous chloride in 0·2 *M* ammonium chloride – ammonia buffer (equal parts). The polarographic curve of this mixture was registered[3].

(*b*) To 1 ml. of 0·1 *N* potassium hydroxide 0·4 ml. serum was added; the mixture was kept at room temperature for 20 minutes, 1 ml. of a 20 per cent solution of sulphosalicylic acid was added and the mixture filtered; 0·6 ml. of the filtrate was added to 5 ml. of the following solution (to 150 ml. *N* ammonia + 50 ml. *N* ammonium chloride + 700 ml. water was added 100 ml. 0·03 *N* hexamine cobaltic chloride). The polarographic curve of the mixture was registered[3].

Every day a sample from a clinically non-cancer patient was used as a standard. The galvanometer sensitivity was 1:200; the strength of reaction was taken as the difference of curve height in millimetres between standard and unknown serum according to the following scheme:

Reaction	0 : lowest	= 0 mm.	or both	= 1 mm.	
	± : „	= 1 „	„	= 2	„
	+ : „	= 2 „	„	< 6	„
	+ :6> „	= 3 „	and highest	⩾ 6	mm.
	+++ : „	⩾ 6 „	„	⩾ 10	„

The results are given in the accompanying block diagram, which shows that the majority of the non-cancer sera fall in the negative group, while the majority of the cancer sera + the 'hepatic' sera fall in the strongly positive groups. *The difference is unquestionable.*

Our present technique and material do not allow statistical treatment or conclusions regarding the future diagnostic value of the reactions. Further investigations are being undertaken for this purpose.

We wish to thank Profs. Waldschmidt-Leitz, Heyrovský, Brdička, Knaus and Novak in Prague for kind personal communications.

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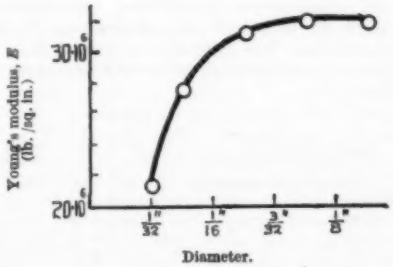
Feb. 19.

[1] Waldschmidt-Leitz, Conrath, Gloeditsch, *Naturwiss.*, **25**, 60 (1937); Brdička, NATURE, **139**, 330 (1937) (see literature there).
[2] Brdička, NATURE, **139**, 1020 (1938).
[3] Brdička, personal communication.

Value of Young's Modulus for Nickel Wire as Influenced by the Diameter

MAKING use of the electro-magnetic method for measuring the frequency of longitudinal vibrations



as described in a previous note[1], tests for Young's modulus have been made on pure annealed nickel

wires of various diameters in the "as received" condition. The results are shown in the accompanying graph, and it will be seen that for wires of diameter less than about 3/32 in. the value of the modulus rapidly decreases with the diameter.

Tests made on copper-plated nickel wires after heating in hydrogen to a condition of maximum magnetic permeability give a similar curve for Young's modulus, but the values are in general somewhat lower.

T. F. WALL.

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University, Sheffield, 1.
March 19.

[1] NATURE, **131**, 351 (1934); also, *J. Inst. Elect. Eng.*, **75** (Dec. 1934).

Reflecting Power of Ultra-pure Aluminium

ELECTROLYTIC polishing of metallic surfaces, which has been studied by one of us[1], does not modify the metal structure. On the contrary, it is known that classical methods of polishing greatly alter the superficial crystalline structure.

Recent work with copper has shown that surfaces polished by the electrolytic process give values of the optical constants which are reproducible, whereas this is far from being the case when surfaces of copper are prepared by mechanical polishing or by evaporation in vacuum[2].

We give here the first results of an optical study of aluminium surfaces prepared from metal 99·998 per cent pure. An aluminium block is laminated to 7 mm. Little strips are then cut (of about 2·3 cm.^{2}) which are polished with emery paper (0–04), covered with paraffin. The metal is recrystallized by heat treatment and the polish is finished on felt disks covered with a suspension of fine alumina (6 and 12 hours). Many of these surfaces were subjected to electrolytic polishing[3] for a time sufficient to allow dissolution of the superficial pellicule formed during the final stage of the polishing. The other surfaces were finally polished on cloth disks covered with alumina (12 hours).

The reflecting powers of these two types of surfaces have been measured by the photo-electric method of Orsel[4] modified by one of us[5]. The filtered light of a tungsten strip lamp is used ($\lambda = 4500$ A.). The seven surfaces polished electrolytically have the same reflecting power within the experimental error (about 1 per cent), and the reflecting power is remarkably constant at every point of each surface. It is observed that the size of the metallic crystallites conditioned by the previous heat treatment has no influence; moreover, the surfaces even after many days exposure to atmospheric conditions, but protected against dust, do not show any alteration. Table 1 gives the results. The reflecting power is given by comparison with a polished surface of galena taken as a standard.

TABLE 1.

Number of sample		3*	5**	7**	8**	15**	17**	18†
Reflecting power	24 hours after polishing	2·23	2·23	2·24	2·24	2·25	2·25	2·24
	72 " " "	—	2·25					
	96 " " "	2·24	2·24					
	120 " " "	—	2·26	—	—	—	—	2·25

* Annealed for 20 hours at about 620° C.
** " " 68 " " " 620° C.
† " " 30 seconds at 350° C.

Table 2 gives the values of the reflecting powers of surfaces mechanically polished. These values are obtained immediately after polishing and they can be compared with the reflecting power of surfaces polished electrolytically.

TABLE 2.

Number of sample	1**	2*	4**	6**	9**
Reflecting power at different regions of each surface	0·61 0·57	0·68 0·66 0·65	0·60 0·62	0·73 0·68 0·69	0·67 0·68

* Annealed for 20 hours at about 620° C.
** " " 30 seconds at 350° C.

This table shows that the reflecting power varies notably from one surface to the other, and that even for a given surface it varies from point to point.

We conclude that ultra-pure aluminium surfaces polished electrolytically have a reflecting power well defined and reproducible. This suggests the use of such surfaces as optical standards. Moreover, such surfaces have a reflecting power greater than that of surfaces otherwise prepared. These observations show that this technique will be useful for the micrographic study of the crystalline structure of aluminium.

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Faculté des Sciences,
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[1] Jacquet, P., NATURE, **135**, 1076 (1935); *C.R. Acad. Sci. Paris*, **201**, 1473; *Bull. Soc. chimique France*, (v), **3**, 705 (1936).
[2] Lowery, H., Wilkinson, H., and Smare, D. L., *Phil. Mag.* (vii), **22**, 769 (1936); Capdecomme, L., and Jacquet, P., *C.R. Acad. Sci. Paris*, **204**, 1415 (1937).
[3] Jacquet, P., *C.R. Acad. Sci. Paris*, **205**, 1232 (1937).
[4] Orcel, J., *Bull. Soc. Franç. minéralogie*, **54**, 301 (1930).
[5] Capdecomme, L., *C.R. Acad. Sci. Paris*, **198**, 462 (1934); **202**, 1843 and 2061 (1936); **203**, 994 (1936).

A Whale Story

MANY readers of NATURE may have heard an incredible story, broadcast by the B.B.C., Regional, on January 11, 1938, in a series of talks called "Strange to Relate", about an alleged James Bartley of the *Star of the East* having been swallowed by a sperm whale and recovered alive from its stomach some hours after. The intelligence of readers of NATURE is such that I expect and hope few if any gave credence to the story, but of the thousands who heard it I fear many must have thought, "It must be true, or the B.B.C. would not broadcast it".

I first came across this story in "Sixty-Three Years of Engineering" by the late Sir Francis Fox, and in reviewing that book for the *Journal of the Society of Engineers* (October–December 1925, pp. x–xiv) I made it amply clear from internal evidence that the story would not hold water. Afterwards, a published letter was found from the widow of the captain of the *Star of the East*, in which she stated that she was on board that vessel at the time of the alleged event, and that there was not a word of truth in it.

Through Dr. Julian Huxley, a member of the Talks Advisory Committee, I was able to bring the facts before the B.B.C. with the result that it was arranged to explain that the story was completely untrue. The correction was made on March 7, but few people who heard it would have recognized it as related to the dramatic story originally broadcast. Because there must be many thousands who heard the story but missed its correction, it seems worth while to record the facts in these columns.

17 Victoria Street, Westminster, London, S.W.1. March 29.

A. S. E. ACKERMANN.

Albino Frogs

SOME years ago, Dr. Nellie B. Eales wrote concerning records of albino frogs[1]. It will be of interest to zoologists to know that on March 28, 1938, a schoolboy found a mass of white spawn in a brook at Coley, Reading, Berkshire. The brook contained many other masses of normal spawn.

The appearance of the spawn was that of clear jelly with milk-white ova. The boy reported the matter to his master, who retained some spawn, and the rest was handed to the Reading Museum by the finder. Except for a small quantity passed to the University of Reading, we have the residue here.

To-day (April 5), many of the eggs have developed into white tadpoles with distinctly pigmented eyes, and slight pigmentation is developing rapidly in the dorso-lateral region. We shall endeavour to rear these specimens, but I shall be happy to pass specimens to any zoologist for scientific work.

It is assumed that one parent was probably a true albino, as in the case of the Woodcote specimens in 1933.

W. A. SMALLCOMBE.

Museum and Art Gallery, Reading. April 5.

[1] NATURE, 132, 278 (1933).

Points from Foregoing Letters

OBSERVATIONS of solar activity made at Canberra, Australia, by A. J. Higgs and R. G. Giovanelli, with a spectroheliosoope and indirectly from a study of conditions in the ionosphere, have related recently observed auroras and magnetic storms to definite periods of activity. The interval, 38 hr., between the solar eruption and the auroral display of January 25–26 appears to be longer than usual (26 hr.).

H. C. Corben points out that, from Eddington's relation between the mass of the proton and that of the electron, the existence of a scalar particle of mass 135·9 can be deduced and this, combined with a positive or a negative electrical charge, will account for the recent observations which indicate that particles of about this mass exist in cosmic rays.

Dr. W. T. Astbury and Miss Florence Bell conclude from an X-ray examination of the sodium salt of thymonucleic acid that the molecule consists of a succession of some 2,000 nucleotides, standing out perpendicularly to the long axis, and spaced at a distance (3·3$_4$ A.) almost exactly equal to the spacing of the succession of amino-acid residues in a fully extended polypeptide. The probable significance of these findings for chromosome structure and behaviour is pointed out.

R. A. Stephen points out that in addition to the purely optical effect as described by Prof. W. L. Bragg and H. Lipson, there are two further effects which may give rise to angular scatter of spots in high-dispersion X-ray photographs. (1) A purely geometric effect due to the finite size or lack of parallelism of the incident X-ray beam. (2) An effect due to the finite width of the lines of the $K\alpha$ doublet. The first effect is insufficient to explain the scatter observed by Müller but the second effect gives results of the right order.

Prof. A. I. Virtanen and T. Laine find that if *l*-aspartic acid and pyruvic acid are added to crushed pea plants, the amino group is transferred from aspartic to pyruvic acid with formation of α-alanine. The authors consider that aspartic acid is the only primary amino-acid synthesized during the fixation of nitrogen and discuss the manner of its formation.

Prof. D. Kostoff submits photomicrographs of chromosomes in the root tip cells of *Triticum Timopheevi* showing differential staining—the distal ends being darker—presumably owing to a greater number of chromomeres. Since the heterochromatic regions have been found to be genetically inert (in the fruit-fly), the author considers that the genes are probably located between the chromomeres.

The spongy furrow on the inner surface of the anterior tibiæ of certain species of Reduviid bugs, which are predators of other insects, serve the purpose of enhancing the gripping power of the tibiæ when the prey is captured, according to N. C. E. Miller. They do not apparently help in climbing, as suggested by previous writers.

Results obtained with the sero-reaction of cancer described by Waldschmidt-Leitz and Brdička are given by F. Bergh, Dr. O. M. Henriques and J. Schousboe. They have obtained positive reactions with the sera of most cancerous patients and with those suffering from certain diseases of the liver, whilst non-cancerous individuals give predominantly negative results. The difference, they state, is unquestionable, but the statistical evidence is insufficient, as yet, to prove the value of the reaction in diagnosis.

A graph submitted by Dr. T. F. Wall shows that for nickel wires of diameter less than about 3/32 in. the value of the Young's modulus (determined by the electromagnetic method for measuring longitudinal vibrations) decreases with the diameter.

Drs. P. Jacquet and L. Capdecomme have studied the reflecting power of ultra-pure aluminium surfaces polished either by the classical mechanical process or by the new electrolytic method. The latter does not change the superficial crystalline structure and gives values very nearly the same at all points of several samples, whereas surfaces polished mechanically show reflecting power variable from point to point and always smaller than that observed after electrolytic polishing.

Research Items

Survivals and Reversions in Javanese Culture

WHAT might be termed a cultural 'backwash' is described by Dr. F. Stutterheim of Batavia in an account of a 'neo-megalith' in Old Batavia (*Bull. Raffles Mus.*, Singapore, 1937, Ser. B, 1, 3). It has been pointed out frequently that many of the so-called Hindu antiquities in Java are nothing but Hinduized versions of pre-Hinduistic holy sites. This is especially noted of monuments found high up in the hills and consisting of terraces and altars in the open. Thus Chandi Sukuh, on the slopes of Mount Lawu, immediately betrays its pre-Hinduistic origin by its lay-out in terraces, though its ornament, especially its reliefs and figures, show a Hinduized style. The main altar, a truncated pyramid, strongly suggests Polynesia and ancestor worship. In Java, such features are usually called "Polynesian" or "old-indigenous". In all instances, the evidence of Hindu art and culture in ornament and relief belongs in style to the latest period of Hinduism in Java. We may, therefore, assume that it represents the ultimate penetration of Hinduistic conceptions, valid for centuries in the plains, into the remote hill districts, where indigenous ideas had lingered on. It is known that the spread of Hinduism in Java was a very gradual process. At the same time, these monuments illustrate the persistence of the indigenous culture. A stronger proof of the persistence of these indigenous beliefs would be the occurrence of a Hindu or Mohammedan sanctuary transformed into a 'megalithic' or indigenous object of veneration. An example of such a transformation appears to be afforded by a recently observed mound covered with stones of different kinds in Kampong Traté of Old Batavia. It was topped by an upright stone of somewhat conical shape, which turned out to be smoothed river stone. Among the stones covering the mound were bricks, and three pairs of Mohammedan tombstones. These removed all doubt but that the original purpose of the mound had been that of Mohammedan burial, but that, probably at about 1700, it had been transformed into a holy place. At the foot of one stone were traces of flowers and incense. The smooth oblong cylindrical stones assembled here are strongly reminiscent of *gandik's* stone rollers for crushing medicinal ingredients, which are considered all over the Archipelago to have strong magical powers.

Amphibian Mesectoderm

Rana japonica has been utilized by M. Ishikawa (*Mem. Coll. Sci. Kyoto*, **12**, Oct. 1937) for investigating the origin and role of the mesectoderm during development and in particular with reference to cartilage formation. The mesectoderm makes its appearance in the early neurula stage. It takes no part in the formation of the neural tube as in Urodeles and migrates solely by the proliferation of its own cells, receiving no contribution from the dorsal part of the neural tube. Normally it migrates ventrally over the mesentoderm in the branchial region, and gives rise to the cartilages of the visceral arches. If it is transplanted into the brain cavity or into the somatic mesentoderm of the side of the body it also produces cartilage. Cartilage is also formed if it is transplanted into the mesenchyme of *Hynobius nebulosus*. Mesentoderm appears to be important but not essential to the production of cartilage by the mesectoderm. By the time of the closure of the neural folds, the mesectoderm is segregated into mandibular, hyoid and branchial units, and an extirpation of any one of them results in the lack of or incomplete development of the corresponding cartilage. The auditory capsule is derived from cranial mesentoderm and not from the mesectoderm.

Testing Insecticides and Fungicides

THE constant production of new materials for the control of pests and diseases of fruit plantations calls for rapid laboratory methods for testing their efficiency. A procedure adopted at East Malling for testing fungicides has recently been described by H. B. S. Montgomery and M. H. Moore, and methods for insecticides are given by W. Steer (*J. Pom. and Hort. Sci.*, **15**, No. 4; 1938). In the former method, 0·015 c.c. quantities of fungicide solution are spread uniformly over circular areas marked on glass slides and allowed to evaporate. 0·04 c.c. of an aqueous suspension of conidia of *Venturia inaequalis* is similarly applied and the slides stored in a saturated atmosphere at 21° C. Counts of germinations are then made at intervals. When desired, the spray deposit may be washed with water to simulate rainfall before applying the fungus. Methods of growing *V. inaequalis* in pure culture, and of assessing the results of treatment are described and the effects of tests with copper- and sulphur-containing materials discussed. Amongst organic substances tried, tetramethylthiuram disulphide was found to be highly fungicidal. The second paper describes the use of eggs of *Orgyia antiqua* L., *Operophtera brumata* L., *Aphis pomi* de G. and *Oligonychus ulmi* Koch, for testing ovicides. *O. antiqua* has also been used for contact and stomach poisons. Females of *O. brumata* are collected in orchards and induced to lay eggs on twigs in special cages. The twigs are then dipped in the insecticide, the toxicity of which is afterwards assessed from counts of hatched and unhatched eggs. Spray materials that show promise are applied to single branches of fruit trees to ascertain any damaging effect on the foliage before extensive field trials are begun.

Cytogenetics of Rice

THE importance of rice as a world cereal has led to much recent work on the genetics of this plant. Two papers by Dr. S. Ramanujam (*J. Genetics*, **35**, No. 2) deal mainly with triploids and their offspring. A sterile autotriploid mutant, which had thicker stems, broader leaves and larger spikelets, appeared in 1933. When grown with diploids, after being vegetatively multiplied, it gave a progeny of 60 plants, ten of which turned yellow and died as seedlings. These plants were derived from 150 good seeds which had been obtained from nearly 41,000 spikelets. A cytological study of these plants showed three nucleoli in somatic telophases, as against two in the diploid. Also three bivalents were attached to the large nucleolus in the pollen mother cells. The

view that rice is a secondary tetraploid with basic number 5 chromosomes, including two pairs of satellited chromosomes, is confirmed. Some rice varieties, however, have but one pair of satellites. It is shown how this condition can arise. In the triploid progeny the chromosome numbers ranged from 24 to 30, with decreasing size of plant according to the number of extra chromosomes. *Oryza sativa* × *O. officinalis* finally gave a single seed which germinated and produced an intermediate sterile hybrid with $2n = 24$ as in both parents. Vegetatively multiplied and grown among *O. sativa* plants, ten seeds were obtained, six of which germinated and all proved to be triploid. The original hybrid showed failure of the chromosomes to pair in meiosis, but in certain cells they all divide in both mitoses, presumably producing diploid gametes which are alone functional. The $3n$ offspring showed extremely abnormal meiosis, with frequent coalescence and degeneration of pollen mother cells.

Stem Rot of the Oil Palm

THE Department of Agriculture, Straits Settlements and F.M.S., has published as No. 21 in the Scientific Series, 1937, a paper upon the stem-rot of the oil palm by A. Thompson, senior plant pathologist. Observations made on a group of 720 oil palms growing on a quartzite soil with a sand-pan situated at various depths below the surface show that a form of stem-rot disease is caused by the fungus, *Fomes noxius*, and that the other fungi present in decaying leaf bases are relatively harmless. *F. noxius* is a facultative parasite which, on penetrating into the stem tissue via the leaf bases, normally extends laterally round the stem and horizontally in the outer stem tissue during the first years following infection; inward penetration then proceeds more rapidly but palms are rarely killed until two or three years after infection. The disease is only serious in areas of deep peat or in quartzite valley soils with sand beds approaching the surface. Control measures are discussed, and it is shown that burial of infected palms is not likely to be dangerous as *F. noxius* does not attack the roots.

Directional Recording of Atmospherics

ONE of the investigations of fundamental importance carried out by the Radio Research Board in Great Britain comprises the study of the nature and origin of the atmospherics encountered in radio reception. For several years past, radio direction-finding methods have been employed to locate the sources of atmospherics, and the results obtained have been compared with the position of storm areas obtained from meteorological data. A paper recently published (*J. Inst. Elec. Eng.*, March) by F. E. Lutkin under the title "Directional Recording of Radio Atmospherics" presents the latest results of this research work. These results have an enhanced value over those previously communicated in so far as they were obtained with an improved type of instrument, which is described in some detail. The directional receiver employed accepts atmospherics only over a sector of 20° unambiguously, and it is arranged to record the direction of arrival of these transient impulses continuously throughout the day. The minimum field strength required to produce a recordable deflection on the instrument is about 0·25 millivolt per metre. The paper deals with the records obtained in Great Britain during the years 1930–33. It is shown that most of the disturbances arrive from the west or south-west, but during summer afternoons sources to the east and south-east are productive; together with storms of a purely local character. It appears from this investigation that the majority of the atmospherics producing disturbance in long-wave radio reception in Great Britain are generated in distant regions of thunderstorm activity. They suffer variable attenuation in propagation, depending upon conditions in the ionosphere over the path along which they travel. In consequence the American sources supply the majority of atmospherics with a field strength exceeding 1 millivolt per metre in England. Summer afternoon and evening sources lie in the thunderstorms of Europe, but American sources always predominate during the night and early morning.

Principles of Violin Construction

In the issue of the *Journal of the Franklin Institute* of March, Mr. P. Jarnak of the Polytechnic, Copenhagen, gives the principal results of the investigations of the violin, viola and 'cello which, with the help of a grant from the Oersted Foundation and the co-operation of the Bell Telephone Co., he has carried out with a view of reviving an art lost soon after the death of Stradivarius in 1737. By electrical amplification and record of the sounds produced by some of the best old and modern instruments he has determined the relative amplitudes of the fundamentals and harmonics which give the most beautiful tones, and for these the body of the instrument must be capable of acting as resonator. The heavy wood back is, the author considers, divided into two coupled resonators by the sound post, the light wood front into four by the bass bar and bridge and these six resonators must be capable of reinforcing the requisite notes. He shows on calculating their possible frequencies from their dimensions that in instruments of good tone they do this—in bad ones they do not. By altering the dimensions of the resonating parts he has improved the tones of poor instruments and has confirmed his theoretical work in a way which should lead to the possibility of producing instruments equal to those of the old masters.

Shape of Eros and its Light-Changes

DR. A. C. D. CROMMELIN has recently issued a paper on the question of the remarkable changes of light to which Eros is liable, these changes having been detected at its second apparition in 1900–1 (*J. Brit. Astro. Assoc.*, **48**, 5, March 1938). Two theories were put forward to account for this phenomenon: (1) differences of albedo on different parts of its surface; (2) departure of its figure from a spherical form. The Johannesburg equatorial at the Union Observatory showed the planet elongated at the near approach in 1931, and it is certain that Eros is dumb-bell or sausage shaped, rotating about an axis perpendicular to its long diameter. The period of light-change is $2^h\ 38^m$, and if the shape is symmetrical this may be only half the rotation period. Jaschek, at Vienna, and other observers, have noted light-changes of much shorter period, and this suggests local irregularities of figure—a condition quite consistent with the fact that cohesion, not gravitation, is the main factor in controlling the form of Eros.

Plant Protection in the Soviet Union

By R. C. Rainey

IN the course of a recent visit to some of the chief Russian entomological research centres, I had the opportunity of seeing something of the headquarters of the Soviet plant protection service, the All-Union Institute for Plant Protection, and also of seeing the Plant Protection Station for the Leningrad Province. In view of the attention which Russian agriculture has attracted in recent years—Vavilov states that the 1937 harvest has proved the largest in history—the following notes may be of general interest.

The more basic agricultural research in Russia is directed by the Lenin All-Union Academy of Agricultural Sciences in Moscow, controlling the work of half a dozen or more research institutes. One of these is the Institute for Plant Protection; another is the Institute of Plant Industry, which has its headquarters in the former Ministry of Agriculture building in the Ulitza Gerzena, Leningrad (Fig. 1), and is directed by Dr. N. I. Vavilov, vice-president of the Academy, whose world-wide investigations into the origins of cultivated plants are now well known, and for whose assistance during the present visit I am particularly grateful.

VIZRa, the Institute for Plant Protection, has its administrative headquarters in the Ulitza Krasnaya in Leningrad, while most of the laboratories are housed in a small palace (Fig. 2), said to have been formerly the residence of Stolypin, Nicholas II's minister, on the Elagin Ostrov, an island in the Neva on the northern side of the city. The gardens occupying the remainder of the island now constitute the Kirov Park of Culture and Rest; a dance for factory workers was in progress in the former ballroom of the palace during one of my visits to the Institute. Something like fifty research workers, together with their assistants, are employed by VIZRa, which is subdivided into a number of sections dealing with ecology, biological control, chemical control, mechanization of control measures, pests of special crops such as grain and cotton, and so on; in the limited time available it was only possible to see a small proportion of the work in progress, even apart from the extensive field studies.

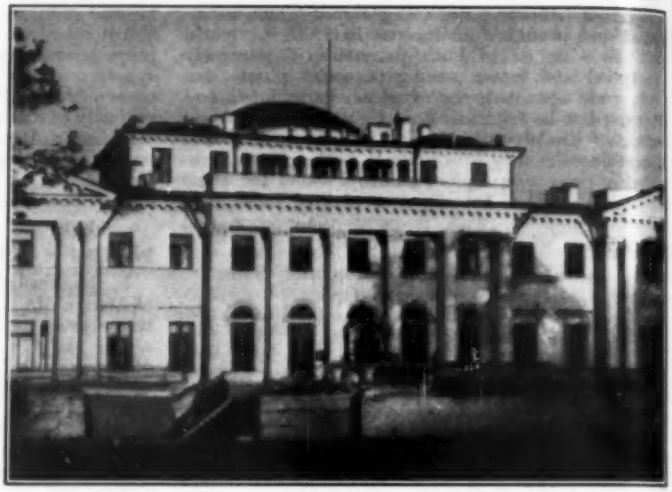

Fig. 2.

LABORATORIES OF THE INSTITUTE FOR PLANT PROTECTION, ELAGIN OSTROV, LENINGRAD.

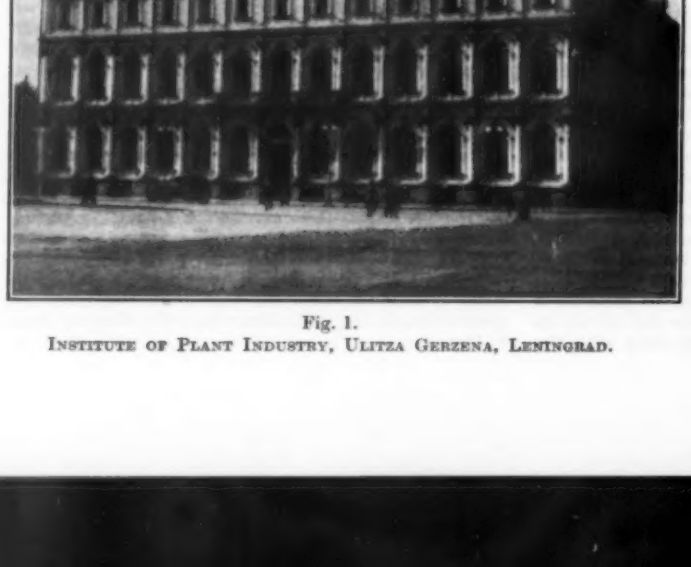

Fig. 1.

INSTITUTE OF PLANT INDUSTRY, ULITZA GERZENA, LENINGRAD.

Dr. J. I. Prinz and his collaborators are investigating problems of soil ecology, working chiefly with the chafer beetles *Melolontha melolontha* L. and *M. hippocastani* F., and with the wireworms *Agriotes obscurus* L., confined to the northern parts of the Union, and *Selatosomus latus* F., a more southern species. Considerable progress has been made in the

difficult task of rearing these long-lived insects under controlled environmental conditions; *Melolontha*, for example, can now be reared without soil from the beginning of the second instar, and its life-cycle is completed in 10–12 months in the laboratory, as compared with four years or so in the field. The optimum conditions for oviposition and for the larval development of *Agriotes* have also been largely worked out.

Dr. I. A. Rubtzov's laboratory is primarily a methodological one, investigating methods of studying the various factors influencing insect numbers. Many of the methods used are those familiar in Great Britain, but they do not appear to be applied uncritically; for example, sulphuric acid and a number of metallic salts are no longer used in the control of humidity, as they are stated to have injurious effects on the experimental insects. Associated with Russian climatic conditions, temperatures down to −20° C. are used in cold-hardiness work. Some interesting work is in progress on the rearing of phytophagous insects such as plant-sucking bugs under conditions of controlled temperature and humidity; large double-walled thermostatically controlled greenhouses are available for the experimental plants. Rubtzov has also carried out important work in Siberia demonstrating phase variation in non-migratory grasshoppers essentially similar to, though less pronounced than, the phase differentiation in locusts.

The biological control section is directed by N. F. Meyer, who has carried out a considerable amount of survey and taxonomic work on the parasitic Hymenoptera, while V. P. Pospelov is in charge of investigations in insect microbiology.

In the chemical control section, which includes the laboratories of insect toxicology, oil emulsions, vegetable poisons, fumigants, and phytotoxicology, Dr. C. J. Bliss, the American statistician, has been working for the last two years on a contract with the Soviet Government; he has been carrying out a programme of theoretical and practical work on the application of statistical methods to entomological problems, with particular reference to the design of experiments for insecticide trials. A new type of spray testing apparatus, incorporating the ideas of Campbell and Tattersfield with modifications suggested by Bliss, and made by the Institute's technicians, has recently been supplied to several of the laboratories. A somewhat similar apparatus is used for laboratory trials of insecticidal dusts; leaves are dusted under controlled conditions in a special chamber, and standard disks of treated leaf are supplied to each insect. The concentration of dust on the leaves is determined by weighing similarly exposed cover-slips of known area on a micro-balance; the amount of dust ingested is determined from the area of leaf eaten, found by mounting the partly eaten disks on squared paper. The method is of course applicable only to stomach poisons. The staff of the chemical control section, like other Soviet workers whose duties involve handling toxic materials, each receive a free extra milk allowance of half a litre daily.

The Plant Protection Station (STAZRA) for the Leningrad Province is directed by Prof. N. N. Bogdanov-Katkov, who also holds a teaching post in the Institute of Applied Zoology and Phytopathology, at which plant pathologists and entomologists are trained. A visit was also made to the field station at Peterhof, about twenty miles out of the city on the sea-coast near Peter the Great's palace. Research is carried on in addition to the advisory work, and recommendations concerning new control measures are circulated among the collective farms of the province. One such new control measure is the use of a naturally occurring hydrated ferrous phosphate to protect seed, particularly seed corn, from various stored products pests, particularly the flour mites *Tyroglyphus farinæ* DeG. and *Glycyphagus destructor* Schr., often associated with the predaceous mite *Cheyletus eruditus* Schr. The ferrous phosphate is found under the peat of the moors of Karelia and elsewhere at a depth of a foot or so; on air-drying, it falls to a fine blue powder which is used as a seed-dressing. It appears to act not as a poison but as a repellent, the mites dying after some weeks apparently from starvation.

The arsenicals generally used against orchard and vegetable pests are calcium arsenate and sodium arsenite and arsenate; the employment of lead arsenate is illegal, on account of the possibility of cumulative poisoning. The alkaloids aconitine and anabasine appear to be used to a considerable extent; another somewhat unfamiliar insecticide is chloric acid, used as a 1/10 per cent solution for the destruction of the eggs of the cabbage root-flies *Phorbia brassicæ* Bch. and *P. floralis* Fall., which cause considerable losses in the spring and summer respectively—cabbage pests generally are of considerable economic importance in this province. The staff of the Station appeared well informed on foreign practice; they were, for example, familiar with the proprietary organic mercury compounds used in Great Britain against smut (*Ustilago* spp.) on cereals.

The field station is chiefly concerned with the mass breeding of the Chalcid parasite *Trichogramma evanescens* Westw. for the control of a number of pests, particularly the codling moth, *Cydia pomonella* L., in apple orchards, and also the pea tortricids, *C. nigricana* Steph. and *C. dorsana* F. The parasites are reared on *Sitotroga cerealella* Oliv.; the stock culture of the latter is maintained in some three tons of grain.

The parasite was originally introduced from abroad, and the mass breeding work has been in progress for the last three years. A number of the collective farms in the province now breed their own *Trichogramma* for release; a peasant came in with a consignment of parasitized eggs from his collective farm for cold-storage at the Peterhof laboratory during the visit there. 2,500 acres of orchards have recently been treated, the parasites being released at the rate of about 120,000 per acre. Complete control is not claimed, but experimental results showing, for example, a reduction in the proportion of infested fruit from 33 per cent in the control areas to 17 per cent in the treated ones were quoted. The results suggest a localization of the activity of the released parasites which does not agree with the rapid dispersion found, for example, with *T. lutea* Gir. in the Transvaal, though environmental differences, mainly perhaps in temperature, may be involved here.

In conclusion, one or two general points concerning accommodation and equipment may not be out of place. Though most of the existing accommodation is of a temporary nature—the Institute of Plant Protection is to follow the majority of the central scientific institutions to Moscow within the next few years—one's general impression was not unfavourable. Equipment was surprisingly good; microscopes, micro-balances, incubators, electric motors and relays, constant temperature rooms, calculating machines, and glassware of all kinds may be mentioned as examples of Soviet-made apparatus apparently fully up to the standard of that in use elsewhere.

Noise and Housing

THE great interest which is being displayed at the present time in quiet housing is reflected in two reports which have reached us: the first, on the "Hygiene of Housing", from an international commission of the Health Organisation of the League of Nations; the other, on the "Construction of Flats for the Working Classes" (H.M. Stationery Office. 1s. net), from a Departmental Committee of the Ministry of Health. Both reports deal with various scientific and other aspects of the housing question, and are in general harmony as to the steps which should be taken in relation to the environmental problem of noise and its bearing on the amenities of housing.

The League of Nations Commission, under the chairmanship of Dr. G. W. C. Kaye, collated the experiences of a number of countries in lessening the nuisance of noise in many circumstances. The report directs attention to the significance of town planning by public or private authorities, with the view of locating dwellings in quiet areas, and securing the co-operation of industrialists in the lay-out of noisy plant. Not only external planning but also the interior planning of dwellings must be given close attention, so that, for example, bedrooms are allocated to the quietest rooms. Then again, dwellings may be insulated against external or internal noise or vibration by sound-proof walls, double windows, composite floors, suspended ceilings, resilient floor coverings, and sound-absorbent surfacings for walls and ceilings. Above all, noises should be reduced or isolated at the source; some countries have resorted to legal enactments and restrictions, but as regards others, research, education and the force of public opinion are more likely to be helpful. Among aggressively disturbing interior noises, particularly for flat dwellers, are powerful loud-speakers, hissing water taps and noisy sanitary fittings. Quieter motor-vehicles would be a boon for those who live and try to sleep in dwellings situated in busy thoroughfares. The report quotes standards of noise-level which are considered desirable and practicable in different classes of rooms in various locations, together with standards of noise opacity of walls and floors for air-borne and impact noises respectively.

The report of the Ministry of Health Committee, under the chairmanship of Sir George Humphreys, is on much the same general lines in its references to questions of acoustics. There is an appendix dealing with noise in working-class flats, which was prepared for the information of the Committee by the National Physical Laboratory and the Building Research Station. The Committee is impressed with the value of composite structures in arresting sound transmission, though it appreciates that the basic principles involved are not yet fully established. The Committee awaits the expeditious prosecution of research into the effects of specific forms of discontinuity in structural systems, and the provision of acoustic data for the different units of construction, not omitting, of course, the all-important matter of comparative cost.

Association between Nematodes and Insects

MR. PROSPER BOVIEN contributes an important paper (written in English) on the above subject, in the *Videns Kabelige Ueddelelseer fra Dansk naturhistorisk Forening*, 101, 1937, which has only recently come to hand. His investigations relate to the family Anguillulidæ, which may become associated with insects in various ways. From a survey of the literature, and his own investigations, the author concludes that these nematodes and insects may be associated in four different ways. (1) Symbiotic association, such species living in the frass or tunnels of wood-inhabiting beetles. Other species live in the nests of ants or termites. The prevalence of a special larval stage ("Dauerlarve" of Fuchs) has been ascertained in some instances. These larvæ may be carried externally, for example, under the elytra of beetles, loosely adhering or protected by a 'cocoon'. In some cases they may invade the gut, pharyngeal glands or the hæmocœl of the host. (2) Species found in dung and decaying vegetation which may pass through larval stages carried by insects loosely attached to the exoskeleton or firmly adhering as 'cysts'. Others have endoparasitic larvæ affecting insects. (3) There are also species which occur as actual parasites in the body-cavity of insects where reproduction takes place. (4) Species which combine parasitic and saprozoic types of behaviour.

Among the life-cycles studied by this author, special mention may be made of that of *Heterotylenchus aberrans* gen. et sp. nov. which is parasitic in the onion fly (*Hylemyia antiqua*) and of two new species of *Neoaplectana* which are abundantly present in larvæ of Bibionid flies. It is believed that the number of species with "Dauerlarven" is much larger than has been supposed. Their extraordinary power of resistance is commented upon and mention is made of finding living larvæ of *Aphelenchoides* in chrysanthemum leaves which had been kept for five years in a drawer in a laboratory. Among flies of the family Psychodidæ, up to 50 per cent were found to carry "Dauerlarven" of *Rhabditis dubia* sp.n. which are lodged externally like tightly fitting rings in the intersegmental furrows of the abdomen. When placed in dung, which harbours a rich population of Psychodidæ, these larvæ developed into adults in a few days. The paper is one of more than ordinary interest, commended to the notice of zoologists as well as to the specialist.

Science News a Century Ago

Arrival of the *Sirius* and *Great Western*

ON the morning and afternoon respectively of April 23, 1838, the S.S. *Sirius* and the S.S. *Great Western* anchored in New York Harbour. The former had made the passage from Cork in nineteen days and the latter the passage from King Road, in the Severn, in fifteen days. Their arrival was the occasion for a remarkable outburst of enthusiasm. On April 23, 1838, the *New York Herald*, under the heading "The Beginning of the New Age in Steam Power", said, "The feelings of this community, on this occasion . . . can't be described", and the same paper the next day said, "The excitement yesterday was tremendous; from an early hour in the morning until dark, myriads of persons crowded the Battery to have a glimpse of the first steam vessel which had crossed the Atlantic from the British Isles, and arrived at this port. . . . This excitement was further increased by the arrival of the *Great Western*, from Bristol . . . making the passage in fifteen days, thus solving the problem of possibility, and showing what can be done by enterprize, expenditure, courage and skill, in encountering the stormy weather which these two vessels have so successively braved and surmounted."

To Lieut. Roberts, the captain of the *Sirius*, the British Consul wrote on April 23, "I have the honour and happiness to congratulate you on the arrival of your steamship across the Atlantic, at a season when strong gales so generally prevail, thereby having proved that British skill had accomplished a most important enterprise, which will produce a revolution in commercial and social intercourse, of which we are incapable of forming any just conceptions. Permit me, Sir, to add that I have, in common with my fellow subjects of Her Majesty in this City, a further cause of rejoicing, that the honour of accomplishing the enterprise has been achieved by a son of the British Navy, and that it was completed on St. George's Day."

Line of Levels across Northern Syria

AT a meeting of the Royal Society on April 26, 1838, a paper was read entitled, "An Account of a Line of Levels, carried across Northern Syria, from the Mediterranean to the River Euphrates", by W. T. Thomson, with geological and botanical notes by W. Ainsworth. The line of levels was undertaken in connexion with Colonel Chesney's expedition of 1835 sent out to determine the possibility of placing steam boats on the Euphrates and Tigris and so connecting with India by steam. One of the results of the expedition was to show that the bed of the Euphrates was 628 ft. above the level of the Mediterranean. The whole of the district over which the line of levels was carried, said Thomson, naturally divides itself into four regions, each of which is characterized by its relative elevation, and the manners and habits of its population. The first region commencing from the Euphrates comprises the country of the upper chalk and conide limestones, which averages an elevation of 1300 ft. The soil is light, somewhat stony, and of no great depth, and is highly productive in crops of corn and cotton. The second region comprises the country of ostracite limestone and feldspath pyroxenic rocks, having a mean elevation of 450 ft.; the third is the lacustrine plain of Umk about 305 ft. above the Mediterranean and covered for the most part with the gramineous plants which feed the flocks of the pastoral and nomadic Turcomans; and the fourth region, formed by the valley of Antioch, is rocky and irregular with elevations from 220 to 440 ft. It comprises also the alluvial plains of the Orontes.

Smallpox among American Tribes

THE issue of the *Gazette des Hôpitaux* of April 26, 1838, gives the following account of a severe epidemic of smallpox which was prevalent at that time among some American tribes: "The situation in Upper Missouri is appalling. Small-pox, or the 'black disease', as it is called, has chiefly attacked the tribe of the Assinaboins. After death caused by the disease the body becomes quite black and swollen to thrice its ordinary size. People are actively engaged in collecting the bodies and burning them in heaps. The Sioux tribe which has been vaccinated has hitherto escaped infection. Nearly all the tribe of the Mandans, numbering 1,600 souls, who lived above Saint Louis, have disappeared, only 31 being left. The pestilence has attacked the Minaterees or Big Bellies, another neighbouring tribe, with equal violence. The Arickarees as well as the Grees have been almost entirely destroyed. The Assinaboins with a population of 9,000 no longer exist. The great nation named Black Feet numbering 50,000 or 60,000 inhabitants has suffered severely. More than a thousand houses each containing eight inmates have been decimated. It is probable that all the tribes in the Columbia region as well as those extending to the south of Missouri will be affected."

The *Athenæum* and Postal Reform

THE *Athenæum* devoted the leading articles in its issues of April 21 and April 28, 1938, to a review of the "Minutes of Evidence taken before the Select Committee on Postage", printed by order of the House of Commons. The Committee had been appointed largely through the proposed reforms set out by Rowland Hill. Much evidence had been given of the various means used by individuals and business houses to evade the very high rates of postage charged by the Post Office, and in commenting on this the *Athenæum* said, "We might almost say that *fortunately* for trade and commerce, the operation of the government monopoly is counteracted by the clandestine conveyance of letters. The means of evasion are so obvious and frequent, that the post has become only the extraordinary, instead of the usual channel for the transmission of business letters." The postage was then for all intents and purposes little more than a tax and a source of revenue and not a means of promoting trade.

In connexion with the proposal that prepaid envelopes should be provided, it had been suggested that this would lead to forgery. To counteract this, it was proposed that a peculiar paper with lines of thread or silk stretched through its substance should be used. The advantages of such paper were that it would be difficult to make and counterfeit, and by diversifying the colour, material and arrangement of the threads, forgers could be defeated. To illustrate the use of this device, the *Athenæum* instructed Mr. Dickinson, the inventor, to supply paper of this kind for its issue of April 28, which accordingly appeared with some of its sheets made of paper containing fine blue threads half an inch apart.

Societies and Academies

Dublin

Royal Dublin Society, February 22.

PHYLLIS CLINCH, J. B. LOUGHNANE and P. A. MURPHY: A study of the infiltration of viruses into seed potato stocks in the field. The infiltration of viruses into seed potato stocks in the north-west of Ireland was studied. The only viruses found were *X*, *B* and *A*. It was found possible to grow stocks for six years without incurring any virus infection.

J. B. LOUGHNANE and P. A. MURPHY: Dissemination of potato viruses *X* and *F* by leaf contact. Virus *X* (*Solanum virus* 1) spread freely to potatoes under controlled experimental conditions both under glass and in the field by leaf contact, virus *F* (*Solanum virus* 8) was found to spread similarly under glass, and there is evidence that virus *B* (*Solanum virus* 4) can be conveyed in the same way. Some potato viruses are transmitted by leaf contact as well as by insects.

E. J. SHEEHY and W. KEARNEY: The occurrence of the uræmic condition in chickens, and its relation to protein and other dietary factors. Evidence is presented to show that this disorder is connected with both the protein and the non-protein constituents of the dietary, and that it is controllable.

G. T. PYNE and L. O. DROMA: The role of albumin in cheese-making. Experiments on the preparation of Cheddar cheese from pasteurized milk to which albumin had been added both before and after pasteurization show that the detrimental effect of pasteurization on cheese-making (in so far as it acts through its effect on albumin) is due to precipitation of albumin on the casein micelles rather than to any change in the soluble albumin content of the milk.

Edinburgh

Royal Society, March 7.

W. T. GORDON: *Tetrastichia bupatides*, a carboniferous Pteridosperm from East Lothian. On the theory that magmatic waters emitted from volcanoes in eruption might decompose the ashes and thus produce petrifying solutions, a successful search for petrified plants was made at Tantallon Castle, East Lothian, in ashes of Lower Carboniferous age. One of these plants, *Tetrastichia bupatides*, possessed a stem with central xylem cylinder, cruciform in section, and, save for the spiral protoxylem elements, composed entirely of reticulately thickened tracheids. The petiole at certain levels had a trace similar to that described in *Lyginorachis papilio*, and the sclerotic elements resemble those found in *Telangium affine*. The new plant has the simplest structure of any known Pteridosperm.

N. W. RADFORTH: An analysis and comparison of the structural features of *Dactylotheca plumosa* Artis and *Senftenbergia ophiodermatica* Göppert. Of these two Carboniferous fern-like compressions, the former has been regarded as a true fern with annulate sporangia, while the latter was believed to be a Pteridosperm from the nature of its apparently exannulate sporangia. However, this analysis has shown that the fructifications of *Dactylotheca plumosa* are definitely annulate and identical with those of *Senftenbergia*. Moreover, from a comparison of other structural features it is clear that these two fossils are merely different parts of the same plant, and therefore can no longer be regarded as belonging to separate genera. Since the name *Senftenbergia* has priority, this genus must now embrace the forms previously described as *Dactylotheca plumosa*. The spores, which hitherto had not been revealed, have been isolated from the sporangia in their various developmental stages. Both the sporangia, the structure of which has been worked out in detail, and the mature spores which are characteristically ornamented, resemble so closely the sporangia and spores of the living fern *Aneimia* that the view of a possible relationship between *Senftenbergia* and the living Schizaeaceous ferns to which *Aneimia* belongs, is now greatly strengthened.

A. C. AITKEN: Studies in practical mathematics. (3) The application of quadratic extrapolation to the evaluation of derivatives and to inverse interpolation. The first part of the paper shows how to interpolate by quadratic proportional parts (quadratic extrapolation) for the value of a function and several of its derivatives at the same time. The second part of the paper shows how quadratic extrapolation may be made available for inverse interpolation. A set of crude approximations to the desired value of the variable, given by ordinary proportional parts, yields in general very accurate values when treated by quadratic extrapolation.

Paris

Academy of Sciences, February 21 (*C.R.*, **206**, 545–632).

ALFRED LACROIX: The granular rocks found with the ankaratrite of Takarindoha, at Madagascar.

GEORGES BOULIGAND: The distance of a variable point to a fixed ensemble.

JULES DUBOURDIEU: Absolutely monotonic functions and the mathematical theory of assurance accidents.

E. J. GUMBEL: The prediction of floods.

KENTARO YANO: Remarks relating to the theory of spaces with conformal connexion.

KARL MENGER: An abstract form of the generalized theorem of Borel-Lobesgue.

CHRISTIAN PAUC: Semi-continuities of inclusion in the general spaces of Fréchet.

DRAGOSLAV S. MITRINOVITCH: Geometrical problems where various differential equations intervene.

V. A. KOSTITZIN: The general differential equations of the problem of natural selection.

JEAN DELSARTE: A new extension of the idea of almost periodicity.

GEORGES VALIRON: The Borel directions of metamorph functions of infinite order.

MARCEL SÉDILLE: Extension of the methods of calculation of the wheels of axial turbo-machines.

MAURICE DENIS: The aerodynamics of a wing in vibration.

JEAN MANDEL: The equilibria by parallel sections of soils and of media plastic at the limit of flow.

FÉLIX CERNUSCHI: The adsorption of gases by surfaces as a particular case of dissociation equilibrium.

FRANS VAN BERGEN: The variation of the resistivity of an electrical conductor placed in a magnetic field.

PIERRE VERNOTTE: A new solution of the problems of heat, allowing the commencement of the propagation to be studied in all cases.

F. BEDEAU and L. HERMAN: A new amplifier with valves for weak currents.

MIROSLAW ROMANOWSKI and MAXIME PICARD: A potentiometer bridge for the comparison of standards of electrical resistance.

EMILE PIERRET and CHARLES BIGUENET: A resonance phenomenon observed in electronic oscillations of triode valves.

NOEL FELICI: The movement of supraconductors.

GEORGES CARPÉNI: The electrometry and ultra-violet spectrography of croconic acid. The comparative constitutions of rhodizonic and croconic acid.

PAUL LAFFITTE and ANDRÉ PARISOT: The projection of flame in gaseous mixtures.

ARNOLD LASSIEUR: A method of determining carbon dioxide based on the electrical conductivity of baryta solutions.

RAYMOND PAUL and GUY HILLY: The preparation of an active iron and its application to the semi-hydrogenation of acetylene derivatives. The iron was prepared by attacking iron-aluminium alloys containing 20–30 per cent of iron with caustic soda solution. At 100° C., and under pressure, hydrogenation is selective, acetylene derivatives giving the corresponding ethylene compounds.

HENRI CLÉMENT and JEAN SAVARD: The methylation of xylene. From a quantitative study of the methylation of xylene by the Friedel and Crafts reaction it is concluded that the reactions leading to the different derivatives are successive and not simultaneous.

ANDRÉ LENOBLE: The chronology of the volcanic eruptions of the massif of Ankaratra (centre of Madagascar).

FRIDOLIN FIRTION: The faunal characters of the Givetian limestones of the Schirmeck region.

JEAN LACOSTE: The style of the internal branches of the south Riffian virgation and the massif of Karia.

JEAN DUFAY and JUNIOR GAUZIT: The spectrum of the aurora of January 25, 1938. This aurora was essentially characterized by the considerable intensity of the two OI red lines with respect to that of the green line and by the presence of the bands of the first positive system of nitrogen.

ALBERT VANDEL: The chromosomes of the Asellota.

GEORGES SCHÆFFER: The origin of the extra heat in the specific dynamic action of proteins.

JEAN ROCHE and MAURICE FONTAINE: The respiratory pigment of the sea lamprey (*Petromyzon marinus*) and on the zoological distribution of the protohæmatinic respiratory pigments (hæmoglobins and erythrocruorines).

R. DUJARRIC DE LA RIVIÈRE and P. GARNAL: The toxicity of the spores of *Amanita phalloides*.

Rome

National Academy of the Lincei (*Atti*, 26, 55–128; 1937).

G. FANO: Observations on some finite geometries (1).

P. BUZANO: Ruled surfaces of the nth order of n-dimensional space having ∞^8 homographies in themselves.

A. CONSIGLIO: The calculation of the integrals contained in Villat's formula relative to a circular corona.

R. L. GOMES: Dirac's matrices in the broad sense.

M. SCHÖNBERG: The function $\delta(x)$ of Dirac.

A. TERRACINI: A possible particularity of the principal lines of a surface (1).

G. N. WATSON: Study of a particular function defined by an improper integral.

P. CICALA: Non-stationary motion of a wing of finite lengthening.

P. GALLITELLI: Chemical analysis of the granite of Montorfano and of the granite and tourmaline of Alzo.

G. GOIDÀNICH: A little-known disease of the vine.

M. BENAZZI: The prehypophysis of *Rana esculenta* does not bring about œstrus in the undeveloped female rat.

E. SACERDOTE: Photo-electric photometer for the determination of hæmoglobin in very dilute solutions of blood.

V. ZAGAMI: Experimental researches on the seminal fluid (2). The *p*H value of the seminal fluid of the cock.

Sydney

Royal Society of New South Wales (71, 1937).

C. E. FAWSITT and R. W. STANHOPE: Viscosities of some complex salts in aqueous solution. Solutions of complex salts containing copper, silver, zinc, nickel and cobalt along with ethylenediamine and pyridine were examined for viscosity. Most of these solutions have a greater viscosity than that of the corresponding simple salts. However, the viscosities of zinc and nickel salts with ethylenediamine are scarcely different from the viscosities of the simple salts. The ethylenediamine copper salts have a lower viscosity than the corresponding simple copper salts. The electrical conductivities of the complex zinc and copper salt solutions (dilute) containing ethylenediamine are slightly greater than those of the simple salt solutions.

A. J. BIRCH: (1) Exudation of *Araucaria Bidwilli*. The exudation is shown to consist of a gum oleoresin, the former containing pentosans, and the latter *d*-limonene and unidentified esters. (2) The α-phellandrene fraction of eucalyptus oils. An extension of the method already described by Birch for the detection and estimation of α-phellandrene is given, which enables the detection of *dl* α-phellandrene in the presence of active substance. The method is applied to the examination of the α-phellandrene fractions of the oils of *Eucalyptus dives*, *E. Risdoni*, *E. Radiata* and *E. Amygdalina*, the first three of these oils containing large amounts of *p*-cymene, and the last dipentene. In no case is *dl* α-phellandrene present. A commercial sample of α-phellandrene contains *p*-cymene and origanene. It is suggested that the presence of *p*-cymene in α-phellandrene largely accounts for the variations observed in the optical rotation.

GERMAINE A. JOPLIN and ALMA G. CULEY: Geological structure and stratigraphy of the Molong-Manildra District. Silurian, Devonian, Tertiary and Recent formations have been recognized, and a detailed description is given of the Palæozoic strata. The Silurian has been divided into an upper (Manildra) and lower (Molong) series. Middle Devonian (Garra Beds) and Upper Devonian (Lambie Beds) are both recognized and all the Palæozoic rocks have been shown to be conformable. It has been pointed out that folding took place during the Kanimbla Epoch at the close of the Devonian, and that the Palæozoic series have been thrown into folds trending a little to the west of north.

[To be continued.]

Forthcoming Events

[Meetings marked with an asterisk are open to the public.]

Monday, April 25

ROYAL GEOGRAPHICAL SOCIETY, at 5.30.—Isobel Hutchison: "Alaska and the Pribilof Islands"—(Geographical Film).

ROYAL AERONAUTICAL SOCIETY, at 8.—(at the Institution of Electrical Engineers, Savoy Place, W.C.2).—H. E. Wimperis: Presidential Address.

Tuesday, April 26

ROYAL STATISTICAL SOCIETY (at the Royal Society of Arts), at 5.15.—Discussion on "Is the Trade Cycle a Myth?" to be opened by Dr. E. C. Snow.

INSTITUTION OF CIVIL ENGINEERS, at 6.—Sir William Bragg, P.R.S.: "The Crystal and the Engineer" (James Forrest Lecture).

Wednesday, April 27

UNIVERSITY OF CAMBRIDGE (in the Arts School).—Prof. E. Cartan: "Geometric Theory of Spinors" (Rouse Ball Lecture).*

Thursday, April 28

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—Prof. Max Born: "The Statistical Laws of Nature" (Kelvin Lecture).

BRITISH PSYCHOLOGICAL SOCIETY, at 8.30—(at the London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1).—Dr. William Brown: "Hypnosis, Suggestibility and Progressive Relaxation and Experimental Study".

CHEMICAL SOCIETY, at 8.—Prof. J. E. Coates: Haber Memorial Lecture.

Friday, April 29

UNIVERSITY COLLEGE, LONDON, at 5.30.—Prof. The Svedberg: "Molecular Migration under the Influence of Centrifugal, Osmotic and Electrical Forces" (succeeding lectures on May 2 and 3).*

ROYAL INSTITUTION, at 9.—Dr. R. N. SALAMAN, F.R.S.: "The Origin of the Potato".

IRON AND STEEL INSTITUTE, April 29–30. Annual Meeting to be held at the Institution of Civil Engineers, Great George Street, London, S.W.1.

Appointments Vacant

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:

ASSISTANT LECTURER AND DEMONSTRATOR IN CIVIL ENGINEERING in University College, Cardiff—The Registrar (May 9).

ASSISTANT LECTURER IN CHEMISTRY in Bradford Technical College—The Director of Education, Town Hall, Bradford (May 14).

ASSISTANT LECTURER IN MATHEMATICS in the University of Manchester—The Registrar (May 14).

ASSISTANT MECHANICAL OFFICER for the Nigerian Government Railway—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1 (quote M./5504).

Reports and other Publications

(not included in the monthly Books Supplement)

Great Britain and Ireland

Some Good Garden Plants. By F. J. Chittenden. Pp. 143+24 plates. (London: Royal Horticultural Society.) [44

Meteorological Office: Air Ministry. Professional Notes, No. 80: A Height-Computer for Use in Aerological Work. By E. G. Bilham. (M.O. 336t.) Pp. 13+1 plate. (London: H.M. Stationery Office.) 3*d*. net. [44

National Institute of Agricultural Botany. Eighteenth Report and Accounts, 1936–37. Pp. 21. (Cambridge: National Institute of Agricultural Botany.) [44

Tanganyika Territory. Soil Erosion. A Memorandum by B. Harrison. Pp. 22. (London: Crown Agents for the Colonies.) [44

National Union of Teachers. Information for Members of Annual Conference, Margate, 1938, including the Executive's Report, Financial Statements, Rules, List of Executive, and Information respecting Provident Society, Benevolent and Orphan Fund, etc. Pp. cl. (London: *Schoolmaster* Publishing Co., Ltd.) [74

This Cruelty Called Sport. By Air-Commodore L. E. O. Charlton. Pp. 48. (London: League for Prohibition of Cruel Sports.) [74

Department of Scientific and Industrial Research. Forest Products Research Records, No. 23: Kiln-Seasoning Treatments of Teak and their Effects on its Wearing Qualities as Flooring. Part 1, by R. A. G. Knight; Part 2, by F. H. Armstrong. Pp. ii+14+5 plates. (London: H.M. Stationery Office.) [74

Register of Attested Herds under the Tuberculosis (Attested Herds) Scheme (England and Wales) and Tuberculosis (Attested Herds) Scheme (Scotland). Pp. 44. (London and Edinburgh: Ministry of Agriculture and Fisheries.) Free. [74

Department of Scientific and Industrial Research. The Investigation of Atmospheric Pollution: Report on Observations in the Year ended 31st March 1937 (Twenty-third Report). Pp. viii+161. (London: H.M. Stationery Office.) 7*s*. 6*d*. net. [74

Fitness Wins: Twenty-four Ways of keeping Fit. Issued by the National Fitness Council. Pp. 64. (London: H.M. Stationery Office.) 2*d*. net. [74

Other Countries

Astronomische Abhandlungen der Hamburger Sternwarte in Bergedorf. Band 3, Nr. 2: Über die Beobachtungen der 13758 Anhaltsterne für das AG-Zonenunternehmen auf der Hamburger Sternwarte in Bergedorf (3. Bergedorger Sternverzeichnis). Von F. Dolberg und J. Larink. Pp. ii+99–136+2 plates. Band 4, Nr. 16: Farbenindizes in den offenen Sternhaufe NGC 1027 und IC 1805 und den Kapteynschen Eichfeldern 26, 35 und 40. Von Martin-Christopher Clasen. Pp. 237–251. (Bergedorf: Verlag der Sternwarte.) [44

Report of the Aeronautical Research Institute, Tōkyō Imperial University. No. 160: Coupled Wing-Fuselage Vibrations. By Katsutada Sezawa and Wataru Watanabe. Pp. 171–194. (Tōkyō: Aeronautical Research Institute.) [44

Cornell University: Agricultural Experiment Station. Memoir 207: The Blossom-Blight Phase of Fire-Blight, and Methods of Control. By E. M. Hildebrand. Pp. 40+3 plates. Memoir 208: A Physiological Study of Dormancy in Seed of Magnolia Acuminata. By Michel Afanasiev. Pp. 37. Memoir 209: A Study of Potato Yellow Dwarf in New York. By L. M. Black. Pp. 23+4 plates. Bulletin 677: Experiments with Cover Crops on Long Island. By P. H. Wessels and John D. Hartman. Pp. 27. Bulletin 679: Economic Studies of Vegetable Farming in New York; 3: Truck-Crop Production and Prices. By E. G. Misner. Pp. 72. Bulletin 680: Development of Highway Administration and Finance in New York. By W. M. Curtiss. Pp. 63. Bulletin 681: Development of Assessment of Property and Collection of Taxes in Rural New York. By F. F. Hedlund. Pp. 51. Bulletin 682: Vegetable-Crop Production in Orleans County, New York. By W. C. Barnes. Pp. 23. Bulletin 683: An Economic Study of Land Utilization in Monroe County, New York. By W. T. Wilson and J. N. Efferson. Pp. 47. (Ithaca, N.Y.: Cornell University.) [44

Publications of the South African Institute for Medical Research. Vol. 7, No. 40: Studies on Insects of Medical Importance from Southern Africa and Adjacent Territories (Part 4). By Dr. Botha De Meillon. Pp. 301–411. Vol. 7, No. 41: Typhoid Fever on the Witwatersrand; Bacteriological Aspects, Serological Diagnosis, Specific Prophylaxis and Specific Treatment. By Dr. W. Lewin. Pp. 413–550. (Johannesburg: South African Institute for Medical Research.) [44

A Report on the Technical Colleges of South Africa. By Dr. F. H. Spencer. Pp. 65. (New York: Carnegie Corporation.) [44

Rubber Research Institute of Malaya. Planting Manual No. 7: Rubber Growing, Elementary Principles and Practice. Compiled and prepared for Publication by A. Moore from Material supplied by Members of the Staff of the Institute and in consultation with the Department of Agriculture, S.S. and F.M.S. Pp. 82. (Kuala Lumpur: Rubber Research Institute of Malaya.) 50 cents. [44

Ceylon. Part 4: Education, Science and Art (D). Administration Report of the Acting Director of Agriculture for 1936. Pp. 85. (Colombo: Ceylon Government Press.) 1 rupee. [44

League of Nations: Child Welfare Information Centre. Summary of the Legislative and Administrative Series of Documents of the Child Welfare Information Centre to December 31st 1937. (Series of League of Nations Publications, IV, 3.) Pp. 52. (Geneva: League of Nations; London: George Allen and Unwin, Ltd.) 1*s*. [44

Twenty-fifth Indian Science Congress, Calcutta, 1938. The Structure of the Himalayas and of the North Indian Foreland. By D. N. Wadia. (Presidential Address, Section of Geology.) Pp. 28+1 plate. (Calcutta: Royal Asiatic Society of Bengal.) [44

Imperial Council of Agricultural Research. Miscellaneous Bulletin No. 17: A Brief Survey of some of the Important Breeds of Cattle in India. Pp. iii+45+52 plates. (Delhi: Manager of Publications.) 2 rupees; 3*s*. 6*d*. [44

Department of Agriculture, Straits Settlements and Federated Malay States. General Series, No. 29: The Cultivation of Lowland Tea at the Central Experiment Station, Serdang. By J. L. Greig. Pp. iii+31+8 plates. (Kuala Lumpur: Government Press.) [74

Indian Central Cotton Committee: Technological Laboratory. Technological Bulletin, Series A, No. 41: Spinning Tests on Punjab-American 4F Cotton with different Schemes of Drafts in the Speed Frames. By Dr. Nazir Ahmad. Pp. ii+12. (Bombay: Indian Central Cotton Committee.) 8 annas. [74